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Entrepreneurial Teachers: The Novice and the Experienced

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Abstract

Teacher entrepreneurship has been receiving growing attention in the field of education over the past 15 years in both scholarly and informal literature. However, the existence of preconceptions, various definitions of the term, and an overall lack of research in the area has resulted in a complex but underdeveloped understanding of the concept. Hence, much attention and clarification are required to recognize who such teachers are and how novice and experienced teacher entrepreneurs act. In chapter two of this study, we start with a systematic literature review of teacher entrepreneurship to recognize the existing state of the field in current literature. We chose to focus on the definition which considers teacher entrepreneurs as those who are entrepreneurial themselves and in their work and can be categorized as social entrepreneurs. A total of twelve competencies and characteristics were extracted from the literature which teacher entrepreneurs exhibit. In chapter three, we qualitatively analyzed a novice STEM teacher entrepreneur's work throughout her first STEM teaching experience in an informal environment to understand how their professional identity developed as a new teacher and realized that this development closely resembled the self-authorship framework for personal identity development. In chapter four, we qualitatively studied the same novice teacher entrepreneur's display of entrepreneurial competencies based on results from chapter one with consideration of their identity development framework based on results from chapter two. Chapter four findings showed how novice teacher entrepreneurs differ in exhibiting entrepreneurial competencies in comparison to more experienced teachers, and how length of program and stakeholder expectations were challenges facing the teacher in the informal STEM education

environment. Finally, in chapter five, through a detailed conceptual comparison of multiliteracies and teacher entrepreneurship competencies from chapter one, and practical examples from a multiliteracies classroom, we argue how experienced multiliteracies teachers can be considered as an example of experienced teacher entrepreneurs. Because of this similarity, by looking into the entrepreneurship field, we then offer innovative ways to support multiliteracies teachers better. Overall, this study contributes to work on teacher entrepreneurship, STEM informal settings, multiliteracies, and teacher development.

Keywords

Teacher entrepreneurship, teacher identity development, informal STEM environment, multiliteracies, teacher education, entrepreneurial teachers

Summary for Lay Audience

When we hear the word entrepreneur, we usually think about someone who starts a business and makes plenty of money. What is normally not explained is that there are different types of entrepreneurs and not all entrepreneurs solely focus on financial gains. The word teacher entrepreneur has gained some popularity over the previous 15 years. However, not everyone knows what it refers to, or even agrees on its definition. So, in this thesis, I investigated what current research on teacher entrepreneurship tells us about these teachers and how they behave. I present the common competencies they have been said to have and study an example of a novice and experienced teacher entrepreneur to better understand their behavior, both theoretically and in action. Using my findings, I also suggest ways to better support new and experienced teacher entrepreneurs.

Co-Authorship Statement

This integrated-article thesis consists of four research papers co-authored with Dr. Mi Song Kim. Chapter two of this thesis has been published in the Entrepreneurship Education and Pedagogy journal. Chapter three has been published in the Research and Practice in Technology Enhanced Learning journal. Chapter four has been submitted to the Entrepreneurship Education journal and is currently under review. And chapter five has been submitted to the Journal of Education for Teaching and is currently under review. Dr. Mi Song Kim, the PhD candidate's supervisor, provided guidance and feedback for the studies and she fully supports the inclusion of the articles as chapters for Najmeh Keyhani's Doctoral dissertation.

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Preface

Chapters three, four, and five of this study benefitted from data gathered as part of the study titled “A pilot study: Understanding the lived experiences of teachers in a technology-enhanced curriculum”. This study had an ethics approval (file #104799) from Western University (Appendix B) and I was given permission to use data from the project, by Dr. Mi Song Kim (Appendix A). The letter of information from the main study can be found in Appendix C, along with the consent forms in Appendix D.

Chapter 1

1 Introduction

This integrated-article dissertation is an interdisciplinary work which bridges together the fields of curriculum and entrepreneurship, to better understand and depict complex concepts that require such an approach, and to explore mutually beneficial knowledge and ideas which have been left unnoticed. I explore the realm of entrepreneurship and teachers, both novice and experienced ones. I look at practical and theoretical data and seek to carry out the interdisciplinary work which the 21st century requires of us.

1.1 Problem Statement

Teacher entrepreneurship has received increasing attention over the past 15 years. However, the concept remains very underdeveloped and understudied, especially from a scholarly viewpoint. In general, entrepreneurship itself is a very commonly misunderstood concept with a myriad of definitions available for it, which means it can become even more confusing when spoken of in new contexts. To those outside of the entrepreneurship field, an entrepreneur is usually assumed to be someone who merely sets up a business. Even though there are definitions which do emphasize the need for setting up a business, or even refer to it as the main requirement for entrepreneurship (Savoiu, 2010), most scholars think differently. Drucker (2014) defines the entrepreneur as one who “always searches for change, responds to it and exploits it as an opportunity” (p. 33). Such definitions are not well heard of in the curriculum field, even though they

can open up much space for new and flexible understandings which are easily more relevant to the field. Therefore, the use of the concept of entrepreneurship continues to grow quickly in the formal and informal curriculum literature, while systematic scholarly insight into the topic remains incomplete and deficient. As we learn more throughout chapter two, most efforts in this regard focus on teachers who teach entrepreneurship, and not teachers who are entrepreneurs themselves. Without a proper understanding of the concept, we cannot follow its development, learn from it, discuss it with common and familiar language, or contribute to it where needed.

I speculate what aggravates this lack of interdisciplinary understanding, is the general resistance seen in attitudes towards business-education partnerships (Despres, 2003). Over a century ago, the application of scientific management to school systems gave birth to a damaging and long-lasting wave of standardized tests and teacher control mechanisms which compared schools to factories and ultimately, lowered educational quality (Au, 2011). With the privatization of education, critical educational content was compromised for the sake of the economic prosperity of corporations, while weakening the backbones of public education and equity (Barlow & Robertson, 1994). As disapproval with all types of public services increased and the belief that market logics were the solution to societies' problems prevailed, ethical considerations were ignored, and democracy undermined (Giroux, 2014; Harvey, 2010). Central to many of such discussions on the impacts of privatizations and corporations on education, is the notion of entrepreneurship. However, this negativity linked to entrepreneurship can be traced back to the strictly commercial and economic aspects of the concept, whereas entrepreneurship can take on much more different shapes and forms which can be

significantly more desirable to those in the curriculum field. Unless scholars approach the topic without the historical preconceptions mentioned above, the potentially appealing and beneficial interpretations of entrepreneurship will be left unknown. Apart from the lack of adequate literature on the topic of teacher entrepreneurship, there is also not enough scholarly work in the field of curriculum which carries out such interdisciplinary work without predetermined disagreeable mindsets.

1.2 Research Questions

In this thesis, I set out to fill in the mentioned gaps by delving into the meaning of teacher entrepreneurship through theory and practice. Then, I look at two scenarios: a novice STEM teacher in an informal setting and an experienced multiliteracies teacher in a formal setting. By studying these two cases, I seek to find out how their work relates to teacher entrepreneurship and whether we can support teachers better with the help of entrepreneurship literature. More specifically, my main research question is: who are teacher entrepreneurs? To respond to this question, I pursue the following three sub-questions:

- What does current literature tell us about teacher entrepreneurship?
- How do novice teacher entrepreneurs think and act?
- How do experienced teacher entrepreneurs think and act?

Figure 1 shows how chapters 2-5 answer the research questions mentioned above.

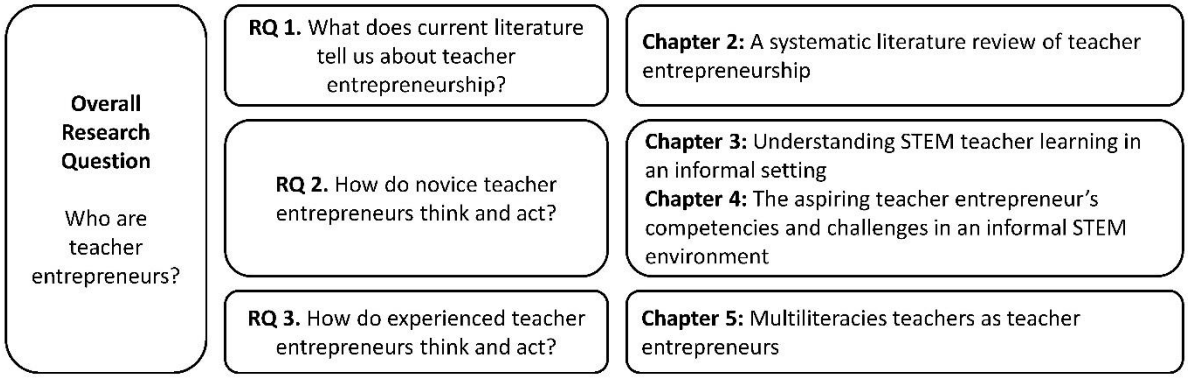

Figure 1. Relationship Between Research Questions and Thesis Chapters.

1.3 Positioning the Researcher

Before becoming acquainted with the field of Curriculum Studies, I received my master's degree in Entrepreneurship from University of Tehran, Iran. From the very beginning of my Ph.D. studies, I was passionate about bringing my two areas of knowledge together. Throughout my first year of studies, I doubted my decision as I learned in-depth about the negative effects of privatization and capitalism on the education system overall. This information changed my views on entrepreneurship by enabling me to take on a critical approach to it as opposed to the previous blind interest which I had initially gained towards the field. However, my years of research on the topic of entrepreneurship had given me a solid understanding of the various aspects of it which I felt did not all necessarily have the same motivations and agendas behind them. Therefore, over time I saw myself once again being drawn to the interdisciplinary approach I initially had in mind, although with a much clearer focus on how to best choose my research areas. I was familiar with the different types of entrepreneurship and saw how social entrepreneurship could possibly relate to the curriculum field because of the shared values it promotes such

as adaptability, innovation, and most importantly, social change (Dees, 1998). I saw how the concept of teacher entrepreneurship is loosely defined without a proper understanding of the meanings it could possibly take on. Therefore, I set out to explore the topic in the educational setting (as opposed to an economic one). In this process I discovered similarities between teacher entrepreneurship and educational pedagogy such as multiliteracies which I also took on the liberty of exploring.

My own diverse teaching experience also provided me with guidance and insight throughout this work. I have either taught or been part of teaching courses on English, STEM (pedagogy, graphic design, coding, etc.), assessment, entrepreneurship, and research methodology to both children and adults in formal and informal settings. I was able to depend on these first-hand experiences of mine to complement my literature reviews and help me decide which topics are worth pursuing and may equally be important in practice, as well as in theory.

Almost for the full duration of my Ph.D. studies, I have simultaneously been working as a research assistant in my supervisor's research projects on different areas of study alongside my own work. This involvement in a wide range of research projects enabled me to more easily spot potential areas for interdisciplinary work. For example, being part of a project on multiliteracies was where I first realized the possible similarities between entrepreneurship and multiliteracies. Through my research experience, I have also learned a great deal on what constitutes good research both when it comes to content and literature choice, as well as research methodology and the proper justifications for choices in data gathering, analysis, and presentation techniques.

Following the belief that social actions truly and strongly affect the meanings produced around us, I place my work in a social constructivism paradigm which advocates that the phenomena which we set out to study are not clear results of the objective world, but are results of many complex elements, especially social causes (Detel, 2015). This approach manifests itself throughout my work, starting from the topic choice, to the data analysis, and presentation. For example, despite all which I have done to make my research valid and reliable, the fact that the positionality of myself as the researcher is provided shows my acceptance of my personal role in shaping all that has been analyzed and presented in this study. The topics of my study are also all by no means separate from how they have been presented in the literature up to now, which I have used immensely. The concepts of teacher entrepreneurship, teacher progress, and multiliteracies are all constantly changing through theory and practice which is why I also set out to use both theory and practice to discover the relationships and meanings behind them.

1.4 Overview of Remaining Chapters

This integrated article thesis consists of six chapters which will each focus on answering (parts or all of) one or more of the research questions mentioned earlier. Three different data sets and three different methodologies have been used throughout this thesis to create four stand-alone research articles (chapter 2-5) which will together paint the picture of the work I have been pursuing throughout my Ph.D. journey.

Chapter two of this thesis sets the basis for the remaining of the work by seeking to understand and depict what teacher entrepreneurship is and how it has been discussed by scholars in the field up until January of 2019. To do so, a systematic literature review of

peer-reviewed journal articles relevant to the concept was carried out. Through this process, I looked for competencies which teacher entrepreneurs were mentioned to have along with the actions they take in their daily activities. This chapter answers the first sub-question of what current literature on teacher entrepreneurship consists of and is later used in chapters four and five as a basis for looking into novice and experienced teachers' thoughts and actions.

In chapter three, the professional identity development of a novice STEM teacher in an informal setting was studied. Using a qualitative case study approach, the natural progress of an informal STEM teacher was observed using their journal entries, lesson plans, and classroom artifacts. The gathered data was then analyzed using Baxter Magolda's (2004) self-authorship framework which has interconnected dimensions of the epistemological, intrapersonal, and interpersonal. This chapter answers part of the second sub-question by addressing how novice STEM teachers think. This chapter, in addition to chapter two, both become the basis for chapter four which follows.

Chapter four uses entrepreneurial competencies from chapter two and identity development information from chapter three, to analyze the informal STEM teacher's data from a different perspective. In this chapter the teacher is considered a novice teacher entrepreneur and her data was searched for any signs of teacher entrepreneurship. Relevant empirical data is presented and the competencies seen or not seen are discussed. This article answers the second part of the second sub-question by addressing how novice teacher entrepreneurs think and act.

In chapter five, I explore the conceptual similarities I have found between teacher entrepreneurship and multiliteracies. To do this, the multiliteracies teacher's beliefs and

actions are put side by side with the competencies, traits, and actions carried out by teacher entrepreneurs. To analyze multiliteracies, canonical literature consisting of books and articles from leading authors of the field were used and compared to my findings on teacher entrepreneurship from chapter two. Based on the commonalities found, I then searched through the entrepreneurship literature and offered a number of possible new ways of supporting multiliteracies teachers. This chapter responds to the third sub-question of my thesis by addressing how experienced teacher entrepreneurs think and act. The sixth and final chapter in this thesis consists of the conclusion chapter which summarizes the findings of this study and discusses and links together all which has been presented.

1.5 Challenges & Ethical Considerations

I must include here at the beginning that I, myself, was the research participant for chapters three and four. I fully acknowledge that this fact could have impacted the research in many ways by placing me in a complex situation where I was simultaneously taking on the roles of researcher and participant. Possible complexities mostly related to the data analysis as opposed to data creation and gathering because at the time which I was designing and holding the course which data was being gathered from, the topic of this study was not yet determined and we were not even sure whether the data would ever be used. Therefore, it can be guaranteed that previous knowledge about the topic of study did not affect the data that was being created at the time. However, regarding the analysis stage, it is true that studying one's own data and learning activities is a challenging task as it can become very personal and one should be prepared to face feelings such as

disappointment with honesty and openness (Bergroth-Koskinen & Seppälä, 2012). One factor which helped address such feelings was the amount of time which passed between data gathering and analysis. Data analysis for chapter three was carried out about one year after the data was gathered and for chapter four, two years. This duration created adequate time for me to become somewhat disconnected to the data and be able to view it more objectively. Such concerns also point to the importance of a proper research design. As suggested by Lincoln and Guba (2013), data triangulation and process and data audits were used for trustworthiness. Therefore, three data sources were used (journal entries, lesson plans, and artifacts) for data analysis in which my supervisor and peers were also involved to ensure proper procedures were followed and reasonable conclusions were made.

My previous knowledge on entrepreneurship was also one factor which could have affected this work in both positive and negative ways. Because of my previous knowledge, I was aware of the various definitions of entrepreneurship which existed and the potential value in exploring this topic. However, to prevent shaping the topic with economic aspects which at the time made up most of my entrepreneurial knowledge, we ruled out the use of any autoethnographical methods to see only what our educational data was displaying, and always engaged in collaborative research design and data analysis.

1.6 Main Contributions to the Field of Education

1.6.1 Conceptualizing Teacher Entrepreneurship

Entrepreneurship, in relation to education has so far been weakly defined and mostly focused on either economic aspects, or the nurturing of entrepreneurial skills and mindsets in students (Leffler, 2009). Even when speaking of teacher entrepreneurship, educators who teach entrepreneurship to students and aim to develop relevant competencies in them (Peltonen, 2015) are what the main body of available literature focuses on. By carrying out this research, I contribute to the systematic and scholarly conceptualization of teacher entrepreneurship from a perspective which considers the innovative teacher to be at the center of the entrepreneurial act (Martin et al., 2018). This conceptualization organizes the current scattered literature that exists on the topic and provides a coherent image of the concept along with a basic vocabulary which can be used to discuss the topic more easily. Apart from theoretical aspects of teacher entrepreneurship, I also attempt to show what this concept looks like in practice by studying how a novice teacher in an informal setting and a more experienced teacher's work in a formal setting relate to teacher entrepreneurship. Using both theoretical and practical approaches to clarify the field of teacher entrepreneurship, I believe, this research can potentially become a strong basis for future scholarly work in both the education and entrepreneurship fields of study.

1.6.2 Interdisciplinary Connections

By carrying out this kind of interdisciplinary work, I also point to the similarities which can exist between concepts which come from seemingly very different areas. As we become more and more specialized in our fields of work, the risk of becoming disconnected from the patterns which connect disciplines together and to the world increases (Bloom, 2004). This is while it has become evident that to understand and solve the complex issues of the modern world, an interdisciplinary approach is crucial (Danermark, 2019). This study shows how for example, the concepts of entrepreneurship and multiliteracies are highly comparable, and how similar the concepts of social entrepreneurship (Mair & Martı´, 2005) and teacher entrepreneurship (Borasi & Finnigan, 2010) are.

Hence, to better support teacher entrepreneurs or multiliteracies teachers, we now have access to a wealth of new ideas from the entrepreneurship literature, some of which are presented and may prove to be beneficial. While this study is mainly housed in the education literature, it does not pursue how the education literature can possibly benefit the entrepreneurship field. However, I do believe that showing the resemblance between teacher entrepreneurship and multiliteracies also gives scholars in the entrepreneurship field access to new ideas on multiliteracies which they can look into and learn from.

1.6.3 New Approach to Multiliteracies

Multiliteracies was first introduced as a pedagogy over 20 years ago (The New London Group, 1996). However, the clarity of what the pedagogy actually represents and what it looks like in practice remains low throughout the world, therefore, advocating its use and

rallying support for it and for the teachers implementing it is still a major challenge (Kumpulainen & Sefton-Green, 2020). This study contributes to this literature through both theory and practice. In theory, it presents a new perspective to multiliteracies by carrying out an entrepreneurial reading of its components in much detail. This entrepreneurial lens provides possible new and complementary pathways to understanding the pedagogy we currently have at hand and are struggling to grasp and teach properly. In practice, the study provides classroom examples of each component of the pedagogy which is analyzed, in order to help overcome the barrier of putting multiliteracies concepts into practice (Boche, 2014). As mentioned in the interdisciplinary connections section above, this study also offers new and innovative ways to support multiliteracies teachers, using the new entrepreneurial perspective it takes on.

1.6.4 Teacher and Human Identity Development

In this study I also chose to investigate novice and experienced teachers and how their work relates to entrepreneurship. While doing so, I first looked into how a novice STEM teacher's professional identity develops naturally. Literature on STEM teachers' progress remains difficult to understand, as to get a grasp of the topic, one must navigate and put together a variety of work on teacher professional development, training, and perceptions (e.g. Al Salami et al., 2017; Faber et al., 2014; McIntyre et al., 2013). Among this incoherent literature, what is missing even more is research on the progress of informal STEM teachers who may have not undergone the usual teacher education required of teachers in formal settings. My work contributes to this literature of informal teacher

identity development through a longitudinal study of a novice STEM teacher's first curriculum development and teaching experience. The natural teacher progress which becomes evident in this study, shows signs of resembling the identity development process of college students throughout many years of their lives. This revelation means that, apart from informal teacher identity development, this research also contributes to, and strengthens existing adult meaning making (Kegan, 1994) and identity development (Baxter Magolda, 2004) frameworks.

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Chapter 2

2 A Systematic Literature Review of Teacher Entrepreneurship

Teacher entrepreneurship has started to receive increasing attention over the past 15 years. The term teacherpreneur was coined by Davis (2006), a teacher/blogger, to refer to teachers who carry out cross-classroom partnerships to reach common goals and create beneficial learning opportunities for their students. Interest in the topic was seen to increase with a rise in scholarly publications on the topic. However, research in this area is still in its early stages and not much clarity exists about who teacher entrepreneurs are and what their work consists of. In the education field, the existence of both negative and neoliberal connotations of the word entrepreneurship (Groundwater-Smith & Sachs, 2002), alongside positive and innovative references (van der Heijden et al., 2015) complicate and hinder one's understanding of the concept even more. To fill this gap in the literature, we aimed to conceptualize teacher entrepreneurship through a systematic literature review of current scholarly work on the topic. We reviewed the competencies used to refer to such teachers and the actions they carried out. Findings from this study can be a basis for further research in both the education and entrepreneurship disciplines and open more doors for these two fields to learn from and contribute to each other. Results of this study may also facilitate the recognition and support of current teacher entrepreneurs and help pave the way for new entrepreneurs to flourish.

2.1 Theoretical and Conceptual Background

Entrepreneurship in general has been looked at through personality-based and competency-based approaches (Wagener, Gorgievski, & Rijsdijk, 2010). In the personality-based approach, which is also the more traditional viewpoint, Fisher and Koch (2008), believed that genetics play a strong factor in shaping entrepreneurs; meaning entrepreneurs were born entrepreneurs who have inherited the behavior they display. On the other hand, in the more recently-developed competency-based approach, Robles and Zárraga-Rodríguez (2015) emphasized the competencies which entrepreneurs had and believed people can be trained to become entrepreneurs. In this study, we follow the second approach by searching the literature for specific competencies that teacher entrepreneurs are said to have, which can also be the competencies that can be taught and learned, to nurture future teacher entrepreneurs.

Three main perspectives existed in the literature on teacher entrepreneurship based on our initial overview of the topic. The first category consisted of research on teachers in the entrepreneurship education field. In this context, teacher entrepreneurs were referred to as those who developed and enhanced entrepreneurial skills in their students (Peltonen, 2015). Some researchers such as Heinonen and Poikkijoki (2006) emphasized the need for teachers to be entrepreneurial themselves to properly foster entrepreneurial mindsets in their students. But a heavy emphasis was still placed on what competencies were transferred to the students as a result of who the teacher was and what they did (Peltonen, 2015). Because of this emphasis on the students, we decided to exclude most articles in this perspective from our review except for rare cases where we felt enough focus was

placed on the teacher being entrepreneurial. The second viewpoint looked at teacher entrepreneurs in a more traditional sense by linking their work strictly to a form of business development. For example, rural Chinese teachers were studied who had started a business such as a Bed and Breakfast, to increase their income (Wu, 2018), or science teachers in Trinidad and Tobago whose attitude orientations and intentions on "starting a new venture" were assessed (Esnard, 2012). We believe this definition of entrepreneurship is closely knitted to the definition of commercial entrepreneurship which is not an area we wish to cover as scholars in the field of education. Hence, this perspective has also been excluded from our review. The third category which was the perspective we were interested in, considered teacher entrepreneurs as in-service teachers who had entrepreneurial competencies and used them in direct relation to their classrooms or the education system they worked in (Oplatka, 2014). This category itself was divided into two subcategories; those who viewed teacher entrepreneurship as a negative and externally determined behavior (Groundwater-Smith & Sachs, 2002), and those who viewed it as a more positive and innovative phenomenon (Martin et al., 2018). To explore this third perspective and its two subcategories, we attempted to find out what the competencies of such teacher entrepreneurs were and through what actions they put these competencies to work.

2.2 Method

2.2.1 Inclusion and Exclusion Criteria

According to the perspective we chose to study, the inclusion basis of our study was determined to be on current teachers/educators (self-reported or not) who were

entrepreneurial in relation to their classrooms or the educational systems they worked in. The articles considered were not necessarily mainly on teacher entrepreneurship, but they referred to it and addressed it at least at a basic level. We also excluded work on teacher candidates or pre-service teachers as we felt that they would fall into *student* categories and not *teachers*. To ensure we study high quality literature, we decided to study peer reviewed journal articles published at any time until January 18th, 2019 which was the time we started this research. Being written in English was also an inclusion criterion based on our own language limitation.

2.2.2 Search and Abstract Review Methods

For round one, we started by searching ProQuest Education database for the keywords "teacherpreneur[*4]", "edupreneur[*4]", "teacher* entrepreneur[*6]", and "educator* entrepreneur[*6]" which resulted in a total of 489 articles (after removing duplicates), two researchers each went through 20 article titles along with their abstracts. If there were doubts about an article, the full article was acquired for a closer look. If doubts were not resolved, the article was put to discussion in weekly meetings. Criteria were refined accordingly where needed. This process was repeated after 80, 150, and 219 more articles were studied. A total of 21 articles were chosen to study. One article was eliminated as the language was not comprehensible enough and another article was removed as it had similar results from the same data sets. A total of 19 articles were finalized. For round two, the authors snowballed through the 19 chosen articles, and snowballed once again through the results of the first snowballing for more articles. A total of 25 potential articles were chosen and after the application of our inclusion/exclusion criteria, 12 of

them were finalized. We then removed one conceptual article from round one as it overlapped with an article acquired from round two (similar authors and similar information). In the end of round two, 30 articles were synthesized. In addition, a Scopus database search was also carried out as a third round using keywords “teacherpreneur*”, “edupreneur*”, “teacher* entrepreneur*”, and “educator* entrepreneur*” with the same inclusion/exclusion criteria and review process. As a result, nine articles were added which brough the total of articles up to 39. A flowchart of this process can be seen below (Figure 2).

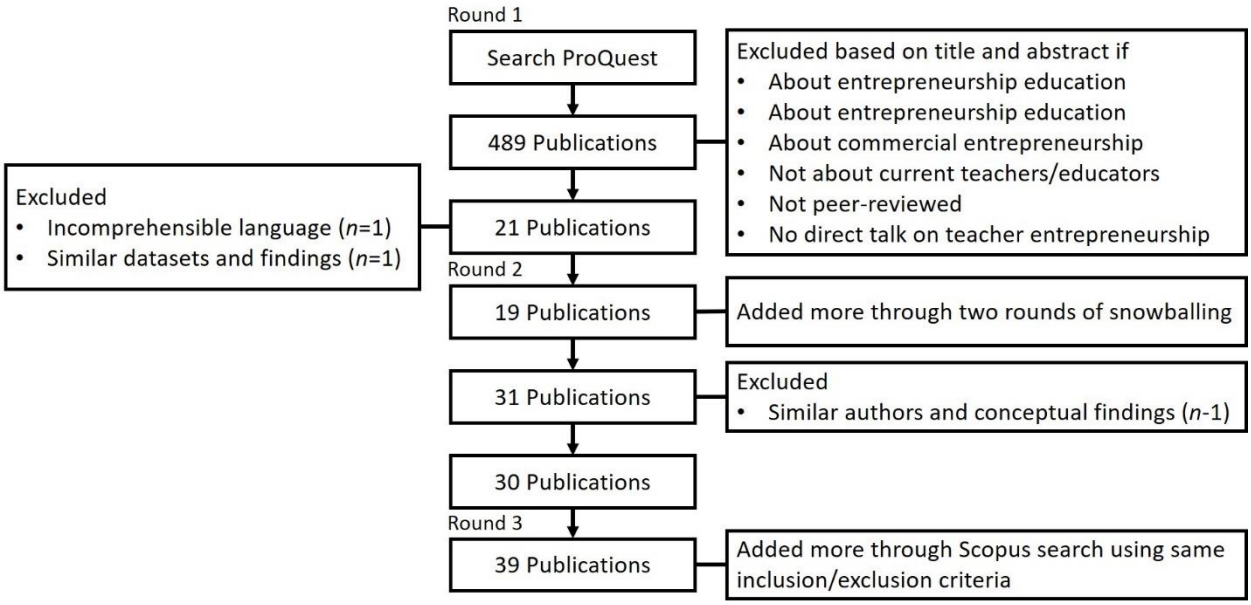

Figure 2. Flowchart of Literature Selection Process.

A shared spreadsheet was created where the researchers recorded basic bibliographic information from the articles along with competencies and actions which the articles had mentioned. The competencies and actions were listed as they appeared in the literature. All items were then printed out on strips of paper and through a constant comparative analysis (Onwuegbuzie et al., 2012), two of the researchers divided them into emergent

categories. For this purpose, open, axial, and selective coding were used with the constant comparative analysis method (Cohen et al., 2007). We considered the competencies and actions we listed from the literature to be our open codes and moved on to axial coding from that point. If a high volume of one competency existed by name, we considered using the phrase as our selective code. As the education field can be hesitant towards economic orientations, we chose the constant comparative analysis technique, often used for theory building, to allow our data to speak for itself (Corbin & Strauss, 2008) and allow the literature to closely guide our word choices. This type of analysis also requires researchers to create categories which encompass all the available data which we believe is another beneficial point when it comes to conceptualizing a new topic with limited literature. Results were put to discussion with a third peer in a series of weekly meetings to help audit our work

2.3 Results

2.3.1 Bibliographic Information and Context of Articles

Article publication dates clearly show how research on teacher entrepreneurship is in its early stages (Figure 3). The oldest article with the terminology of interest belonged to 2001 and an increase in publications was seen over time.

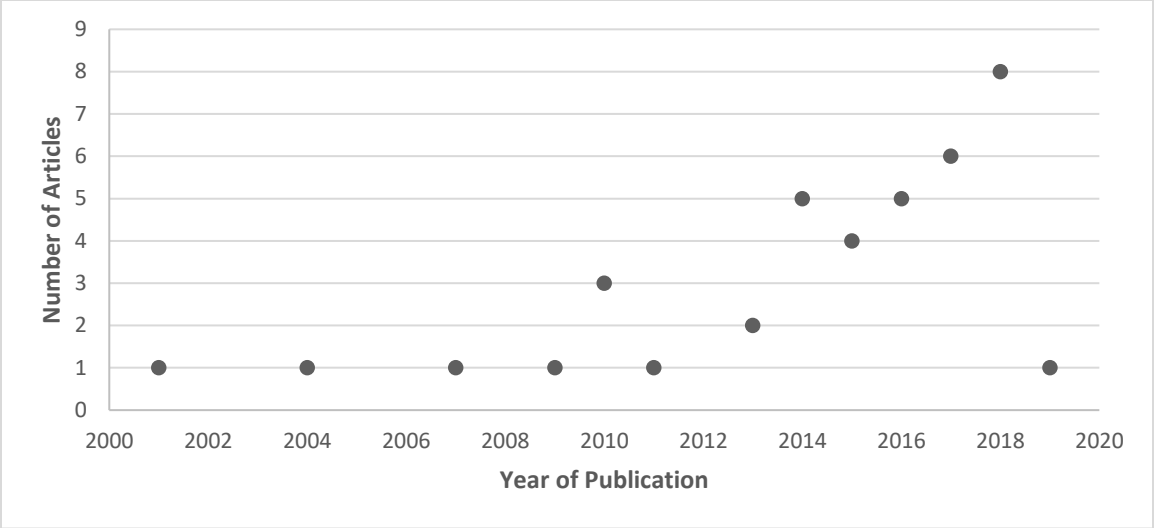

Figure 3. Articles Used by Year of Publication.

The context of the articles was spread out through a variety of different countries, with the most common one being the United States with 12 articles, and after that Australia with three articles (Figure 4). The remaining countries came up either in one or two articles but not more.

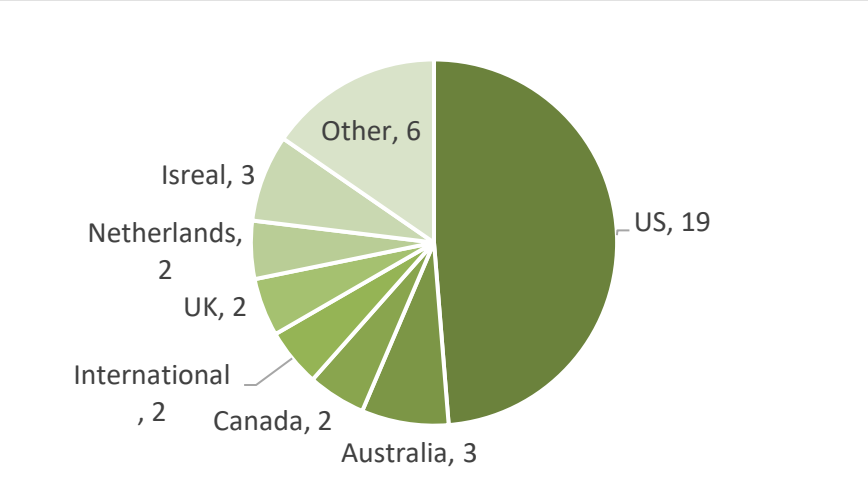

Figure 4. Context of the Articles by Country.

The age range or the level which the educator entrepreneurs in the literature taught to varied, however, K-12 settings were by far the most common levels seen (Figure 5).

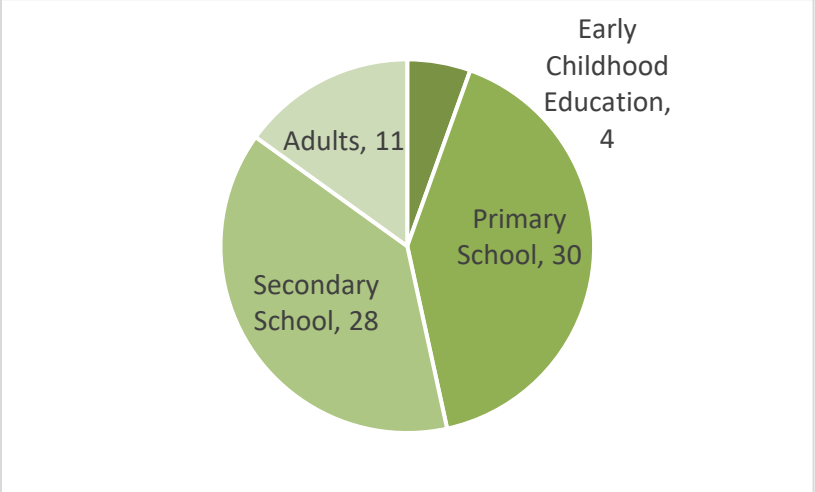

Figure 5. Age Range of the Teacher Entrepreneurs' Students.

As mentioned earlier, perspectives on teacher entrepreneurship which we set out to study fell into two categories. One category referred to them as those who value or give in to standardization and are performance oriented whereas, the other category referred to them as being more innovative and socially motivated. The first group will be referred to here as *performance oriented* and the second group as *social value oriented*. Below we will present our data based on the categories they belonged to.

2.3.2 Performance Oriented Teacher Entrepreneurs

Only five of our 39 articles held this perspective. Two of the articles were also from the same author but with different data sets. We present our review of these articles with the acknowledgement that our information is far from comprehensive. In a study of the Australian context, Sachs (2001) offers two professional teacher identities which have

evolved as a result of educational policy and structure changes: the entrepreneurial and the activist. The entrepreneurial teacher is one who has been shaped under managerialist discourses and is competitive in the fight for resources. Such teachers give in to standardization and are defined by what is dictated to them. Working in isolation (individualism) and prioritizing privacy are two other traits presented for these teachers. The activist teacher professional identity is offered as the opposite to the entrepreneurial one. It is an identity characterized by the value it places on democracy, reflection, and other similar concepts cherished in the education literature.

Castner et al. (2017) believe that claims of teacher entrepreneurs being creative only refer to limited and technical aspects of a teacher's work in the classroom and any other attempts by them, such as social justice efforts, are lost in real world and conversational boundaries that are set to quiet their voice. They also consider entrepreneurship and democratic tendencies as opposing forces and believe neoliberal concepts such as entrepreneurship will only commodify the curriculum and provide a misleading pathway for the future because of the competition and individualism which they bring with them. Other articles which helped shape this subcategory for us recognized and acknowledged the existence of this perspective and defined teacher entrepreneurialism in the same way. However, they also believed that the concept is more complicated and cannot be easily seen as a black or white topic.

In another study, by interviewing teachers from normal traditional schools and those who teach at schools which are part of a top performing network, Keddie (2017) sees a difference in their views towards entrepreneurial professionalism. The teachers from the former group who valued traditional teacher professionalism, saw external high stakes

performance measures as threatening and opposing educational values whereas, teachers from the top performing schools' network embraced this performativity pressure, saw it as an opportunity to shine, and believed such efficiency pressures enhanced their professionalism status by showing them to be as good as the private sector. In another research, Keddie (2018) once again refers to a teacher entrepreneurial professional as one who favors competition, regulation, and compliance, and chooses "external accountability systems" (p. 200) as opposed to prioritizing learners. Using observations and interviews data from teaching and administrative staff of a primary school in England, this study shows that both types of professionalism were able to work hand in hand to support students. The strict entrepreneurial professionalism present was able to push students towards high academic achievements and enhance the school's ranking, but also limit learners' individual voices and agencies.

Hanson (2017) also recognizes the capitalistic and controversial meanings of entrepreneurship in the education field but still insists on using the notion to refer to the positive change brought about by music teachers in order to shape the future based on student needs. The mentioned study used data from an online survey filled by 576 teacher participants and found that teachers with entrepreneurial attitudes were seen to use collaborative approaches more and develop creative curricula compared to others.

2.3.3 Social Value Oriented Teacher Entrepreneurs

Most of the literature we studied held this view of teacher entrepreneurship. Therefore, for the remaining of this study, we will address this body of knowledge.

2.3.3.1 Competencies and actions

Teacher entrepreneurs were talked about in the literature using a variety of competencies and actions. Not all will necessarily be seen in one entrepreneur and some may at times overlap conceptually. However, we have strived to present them in an organized way for better understanding. Table 1 shows the main competencies referred to in the literature along with relevant actions or details. Specific examples from the literature will be given below. The list of articles used for each competency can be found in Appendix E.

2.3.3.1.1 Socially motivated

When referring to teacher entrepreneurial behavior, the word "social entrepreneurship" has been used quite often (Borasi & Finnigan, 2010; Cochran-Smith et al., 2018; Oplatka, 2014; Sherry Chand, 2014). Social entrepreneurship is "a process involving the innovative use and combination of resources to pursue opportunities to catalyze social change and/or address social needs" (Mair & Martı´, 2005, p. 3). Teacher entrepreneurs are individuals who are less concerned about material gains (Amorim Neto et al., 2017) and more concerned about achieving positive social change (Sanchez, 2014). Educator entrepreneurs show a desire to address students' needs by creating value or change inside their classrooms and schools or beyond. For example, within their classrooms they use differentiated instruction and various assessment methods (Dennis & Parker, 2010; Nash, 2014), strive to benefit disadvantaged students (Bills et al., 2015; Keddie, 2018), and equip students with the knowledge and skills they need to survive in the 21st century (Schimmel, 2016). Beyond schools and classrooms, teacher entrepreneurs work to create value at a higher public level. Fighting for policy change (Hess & Finn, 2007), raising

awareness about students' needs and initiatives (Berry, 2013b), and advocating for students and communities (Bills et al., 2015) are instances of such endeavors.

Table 1: Educator entrepreneurs' competencies, traits, and actions

Unique References*	Competency	Subcategories/Details**
29	Socially motivated	Seeking value or change at the school/classroom level
		Seeking value or change beyond the school/classroom level
26	Innovative	Using creative or modern teaching methods
		Departing from establishment ways
23	Collaborative	Collaborating as teachers
		Having students collaborate
16	Proactive	Taking initiative
		Not constrained by what constrains others
15	Opportunity-minded	Always looking for potential for creating value or change
13	Present in work	Being thoughtful and reflexive
		Relying on self
13	Knowledgeable	Having teaching & classroom related knowledge
		Having entrepreneurship knowledge
12	Dedicated	Feeling responsible
		Showing determination
11	Resourceful	Acquiring resources
		Using and managing various resources
10	Risk-tolerant	Dealing with uncertainty
9	Visionary	Having a strategic vision

		Having a boundless vision
8	Self-improvement Oriented	Seeking personal achievements
		Seeking professional growth

Note. *This column shows the number of unique articles which were associated with this competency. **The same article may have contributed to both subcategories of one competency.

2.3.3.1.2 Innovative

After showing a motivation for positive change, being innovative is the most repeated concept in the literature, whether it has been explained or merely referred to as an obvious competency. Using new and modern teaching methods are continuously spoken of when talking about innovation. Some examples from the literature include using an integrated curriculum (Schimmel, 2016), experiential learning, incorporating movement into the learning process (Dennis & Parker, 2010), using meaningful content (Bulger et al., 2016) and technology (Borasi & Finnigan, 2010; van Dam et al., 2010) teacher entrepreneurs also exhibit innovation when they "depart from establishment ways" (Hess & Finn, 2007, p. 51). They oppose or challenge the status quo (Cochran-Smith et al., 2018; Douglass, 2018) and "build new or remake existing organizations" (Maranto, 2015, p. 71).

2.3.3.1.3 Collaborative

Teacher entrepreneurs value collaboration immensely. They collaborate themselves and ensure their students collaborate as well both with each other and the community.

Teachers entrepreneurs collaborate for knowledge sharing purposes (Shelton & Archambault, 2018) and to stay updated on changes in their field (van Dam et al., 2010). Being connected to outside of the classroom simply provides educators with leverage in setting up more and better opportunities for student learning (Hess & Finn, 2007; Pashiardis et al., 2018). For example, teacher entrepreneurs who were promoting road safety in Israeli schools showed much cooperation with each other to create new curricula by putting students from different grade levels into the same activity groups (Oplatka, 2014). Collaboration with the community outside of the school enables teacher entrepreneurs to have a role in educational policy at local and national levels (Holland et al., 2014). Emphasis on student collaboration is also evident. Entrepreneurial classrooms include collaborative work between students and between students and the community (Hanson, 2017). Teacher entrepreneurs are active in their political efforts for awareness building and social change and make sure to involve their students in these processes and communications as well (Bills et al., 2015). Community based activities and curricula (Bills et al., 2015) are promoted to keep students connected with the real world.

2.3.3.1.4 Proactive

Teacher entrepreneurs are known to take initiative and act through self- motivation (Omer Attali & Yemini, 2017; Wilson Kasule et al., 2015). They are enthusiastic and energetic (Leffler, 2009) instigators (Hanson, 2017) who show an “operational translation of symbols and behaviors into actions” (Eyal & Kark, 2004, pp. 215-216). Teacher entrepreneurs do not feel constrained by situations and environments which others are limited and intimidated by (Bulger et al., 2016). For example, during such conditions, a

teacher entrepreneur may adapt by changing their goals (Amorim Neto et al., 2019). When faced with regulations, they do not feel bound by them (Berry, 2013a; Martin et al., 2018) and bend the rules when they can and see fit (Hanson, 2017; Hess & Finn, 2007).

2.3.3.1.5 Opportunity-minded

An entrepreneurial teacher is able to explore opportunities related to their work (Wilson Kasule et al., 2015), meaning they are continuously "proactively seeking and being ready to seize opportunities" (Borasi & Finnigan, 2010, p. 4). Opportunities are often in the form of problems in the classroom or educational system which teacher entrepreneurs believe can be resolved (van der Heijden et al., 2015). In other words, they "capitalize on crisis and dysfunction" (Borasi & Finnigan, 2010, p. 21) by visualizing a solution to the problem and considering it an opportunity to take advantage of (Omer Attali & Yemini, 2017). The importance of spotting and acting on "opportunities" show how the whole process of entrepreneurship revolves around this important notion (Leffler, 2009).

2.3.3.1.6 Present[1] in work

Literature shows that teacher entrepreneurs are very thoughtful and aware of their work. The reflection they put into their work can be seen as they refuse to blindly accept changes or opinions (Keddie, 2017; van der Heijden et al., 2015). They show adaptability

[1] This presence does not refer to any kind of physical presence of the teacher in online or in-person learning environments. It refers to their highly aware and active state of mind when carrying out their work and making decisions.

to changes (Amorim Neto et al., 2019; van Dam et al., 2010), employ effectual reasoning which means they decide based on how they want to shape the future, as opposed to being shaped by the future (Martin et al., 2018), and are also good systems thinkers (Maranto, 2015). They think deeply about classroom data they receive. For example, if results of standardized tests are showing them information which does not match their expectations or previous knowledge of their students, they will search for more data or analyze their existing data through a different approach to find the right answers (Dennis & Parker, 2010). Teacher entrepreneurs also show self-reliance through a strong dependence on their "gut instincts" which is a result of their experience and knowledge of the field and institutions which they work in (Borasi & Finnigan, 2010, p. 18). They are described as autonomous (Yemini & Bronshtein, 2016) teachers who excel at improvisation (Hanson, 2017; Nash, 2014).

2.3.3.1.7 Knowledgeable

Teachers who excel in entrepreneurship have been mentioned to have good knowledge. This knowledge is either related to the teaching profession and the classroom, or entrepreneurship. Teacher entrepreneurs have shown to have good theoretical (Dennis & Parker, 2010; Hunzicker, 2017; Martin et al., 2018) and content knowledge of the topics they are teaching such as music (Bell, 2016; Nash, 2014). Experience in teaching has also been mentioned which can lead to better knowledge in both content and teaching methods (Amorim Neto et al., 2017). A "deep knowledge of students, families, and communities" is also part of the teaching and classroom related knowledge teacher entrepreneurs have (Berry, 2013b, p. 310). Another type of knowledge exhibited by

teacher entrepreneurs is in regard to entrepreneurship itself. Studies show that when teachers know what entrepreneurship is and what it consists of, they are more likely to be entrepreneurial (van Dam et al., 2010). Prior entrepreneurship education and previous entrepreneurship work experience are known to help form this knowledge (Mikkonen et al., 2018). Teacher entrepreneurs are able to build on their previous experiences, learn from them, and move towards higher chances of success (Bulger et al., 2016; Schimmel, 2016).

2.3.3.1.8 Dedicated

Educator entrepreneurs feel deeply responsible to people and their students' needs even when working in the private sector (Aurini & Quirke, 2011). Teacher entrepreneurs are emotionally committed to their pupils (Oplatka, 2014) and see themselves as "responsible for providing high quality education at both classroom and school level" (van der Heijden et al., 2015, p. 693). Also, being accountable to external expectations, for some teachers, provides them with the opportunity to showcase their work and turn into better entrepreneurs (Keddie, 2017). They also show a strong sense of determination through the persistency (Borasi & Finnigan, 2010; Hanson, 2017) and tenacity (Maranto, 2015) they display.

2.3.3.1.9 Resourceful

Teacher entrepreneurs are said to deal with scarce resources by setting out to acquire the resources they need themselves, and skillfully using and managing the resources they do have at hand. Teacher entrepreneurs have shown to secure the funds and resources they

need through various means such as crowdfunding (Bulger et al., 2016) or by networking and gathering political and community support (Bills et al., 2015) or establishing strategic partnerships (Martin et al., 2018). Among the resources which teacher entrepreneurs commonly and competently manage are technology (Borasi & Finnigan, 2010), human capital (Nash, 2014), time (Hanson, 2017), and data (Amorim Neto et al., 2019).

2.3.3.1.10 Risk-tolerant

Experimenting new ideas and technologies in the classroom carry along risks because of the uncertainty they bring along (Amorim Neto et al., 2019; Berry, 2013a). When teacher entrepreneurs step into these unknown paths, they risk losing resources such as money, their reputation, and/or time (Schimmel, 2016). Although this by no means implies that teacher entrepreneurs thoughtlessly take on adventurous activities without proper considerations (van Dam et al., 2010). Research shows that the risks they take are very calculated (Martin et al., 2018; van der Heijden et al., 2015). This calculation also means that over time, teacher entrepreneurs try to minimize the risks involved in their plans by choosing their strategies wisely, and continuously re-evaluating their opportunities with the help of their knowledge and experience (Borasi & Finnigan, 2010).

2.3.3.1.11 Visionary

Literature depicts teacher entrepreneurs as individuals with boundless visions which provide them with continuous guidance throughout their work. Teacher entrepreneurs have strong imaginations (Bell, 2016; Nash, 2014) and idealistic personalities (Maranto, 2015). They can also envision possibilities that exist outside of the classroom

environment (Hess & Finn, 2007) and are able to develop their visions over time, even in the face of limitations (Martin et al., 2018). Their visions shape their work like ideologies (Leffler, 2009) or doctrines (Omer Attali & Yemini, 2017) and act as drivers for all their actions and even who they decide to be (Borasi & Finnigan, 2010).

2.3.3.1.12 Self-improvement oriented

While teacher entrepreneurs are strongly socially motivated to address students' needs, they also place value in their own growth and achievements. Literature shows such teachers actively seek to enhance their knowledge and working conditions by looking for professional development opportunities (Amorim Neto et al., 2019; Bulger et al., 2016; van der Heijden et al., 2015). Even teacher participants in networks which were not fundamentally created for professional development purposes, still pointed out that the professional growth they felt through the networking experience was something they enjoyed (Shelton & Archambault, 2018). Teacher entrepreneurs were described to seek personal achievements because of their desire for interesting and challenging work (van der Heijden et al., 2015), the pleasure in knowing that they had done something no one else had done before (Martin et al., 2018), and the need to strengthen their inner self (Sanchez, 2014). Teacher entrepreneurs are also motivated by personal gains such as competition, networking, financial rewards, recognition, and peer feedback (Shelton & Archambault, 2018).

2.4 Discussion

The bulk of literature on teacher entrepreneurship which takes on a positive and innovative perspective of the concept, clearly points to many elements which are historically common for entrepreneurs in most fields. Universal elements such as perception, uncertainty, change, risk, and innovation (Carlsson et al., 2013) are quite similar to our explanations of teacher entrepreneurs being visionaries, risktakers, proactive, socially motivated change agents, opportunity-minded, and innovative. The Timmons (1985) entrepreneurship model emphasizes a balance between resources, team, and opportunity which involves innovation and also risk. These elements mirror our resourceful, collaborative, and risktaker notions. Our findings also align well with literature on social entrepreneurs who are very responsible (Maak & Stoetter, 2012) and present in their work (Teise & Urban, 2015). We believe that this shows how the core concepts of entrepreneurship can be similar across fields and are certainly not exclusive to the economic field. Timmons and Spinelli (2016) define entrepreneurship as “a way of thinking, reasoning, and acting that is opportunity obsessed, holistic in approach, and leadership balanced for the purpose of value creation and capture” (p. 3). However, it is also clear that even with similar concepts, the representation of entrepreneurship varies from one field to another and it is important to know what these concepts translate into in each field. Results from our work offer an initial conceptualization of teacher entrepreneurship and introduce a more systematic language base and vocabulary for future research to build on. The clearer image of teacher entrepreneurs shows what they are motivated to achieve and how they move towards their goals. This speaks directly to school leaders who have an important role in creating the work environment of teachers.

By creating an open and flexible space which allows mistakes and experimentations, school leaders can allow teacher entrepreneurs to carry out their innovations more freely (Hanson, 2017). Collaboration which has proven crucial to teacher entrepreneurs' work can also be facilitated by all educational authorities at local and national levels through various school to school, school to community, and school to industry programs and infrastructural support. According to the competency-based approach we stated earlier (Robles & Zárraga-Rodríguez, 2015), the competencies which we now know teacher entrepreneurs possess can be developed in teacher education programs for pre-service teachers, or in professional development opportunities provided to current teachers. This is an area of work which policymakers and educational leaders of teacher education programs can take into consideration.

2.5 Future Research

There are four future research pathways which we suggest can be pursued following this study. First, since the literature showed how strongly teacher entrepreneurs are socially motivated, we believe a conceptual comparison between our results and competencies of social entrepreneurs specifically can be useful to complement the conceptualization we currently have by either validating our results further or analyzing the differences that exist between them. Second, much of the work that made up the body of literature which we studied was not specifically about teacher entrepreneurship. Therefore, we believe a next step to put our conceptualization to test would be an empirical in-depth study of a number of teacher entrepreneurs at work, or a study which measures the existence and strength of the competencies listed in this work in teacher entrepreneurs. Third, our

review showed peer reviewed journal articles on teacher entrepreneurship are scarce, whereas the topic started to get attention years earlier in informal literature such as weblogs or in grey literature. We believe such literature is also highly worthy of its own study and can add a great deal of value to this body of knowledge. Fourth, research on how the competencies of teacher entrepreneurs can best be embedded in teacher education and teacher professional development programs can be a very useful step for implementing this study, along with research on best practices for supporting existing teacher entrepreneurs.

2.6 Limitations

Several limitations exist in our study. At times we saw an overlap between leaders/business owners, and teachers/educators (Borasi & Finnigan, 2010; Pashiardis et al., 2018; Sanchez, 2014) which we tried to prevent by eliminating literature that talked about entrepreneurship at an organizational level or entrepreneurship simply in the business sense. However, the line between these groups was blurry at times for example, when some business owners self-identified as educators (Aurini & Quirke, 2011). Also, as mentioned earlier, many of the articles in our study were not specifically on teacher entrepreneurship, therefore, much of the data may have been simple references to such teachers' competencies and actions without much elaboration of the claims. For this reason, we have claimed our work to be an initial conceptualization of the topic which needs further validation. Another limitation of this work is the amount of overlap which existed between the competencies. Although we placed competencies and actions in the chosen categories, many of them would have fit well into other competencies as well.

Therefore, even though we expect some level of value in the number of references for each competency, we do not believe we have been able to list the competencies by order of importance at this point.

2.7 Conclusion

Teacher entrepreneurship is a growing field which is understudied and underdeveloped. The sooner we understand the phenomena, the better equipped we can be to follow its development path and attempt to support teacher entrepreneurs both in practice and theory. In this study we confirmed that teacher entrepreneurship is also closely linked to universal entrepreneurship concepts. But we also went into detail to see what those concepts look like in practice as each context and field is unique with its own settings. Our findings show that teacher entrepreneurs are socially motivated individuals who are innovative, collaborative, proactive, opportunity-minded, present in their work, knowledgeable, dedicated, resourceful, risk tolerant, visionary, and self-improvement oriented. Actions related to these competencies and traits along with more detailed examples from the literature were given to create a clearer picture of educator entrepreneurship. Knowing what teacher entrepreneurship looks like allows us to recognize the phenomena once we see it, learn how to better support existing entrepreneurs, and pave the way for new entrepreneurs to flourish.

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Chapter 3

3 Understanding STEM Teacher Learning in an Informal Setting: A Case Study of a Novice STEM Teacher

Research on informal STEM education over the last ten years or so has indicated that informal learning environments help increase students' learning in STEM (Ghadiri Khanaposhtani, Liu, Gottesman, Shepardson, & Pijanowski, 2018; Mohr-Schroeder et al., 2014). As a result, much effort has been put into promoting student participation in STEM focused informal education activities in many countries around the world including Canada and the U.S (Kim, 2017). Clearly, creating a STEM literate society is closely linked to education, and a main component of this education is the STEM teachers involved. Hence, emphasis on STEM teacher education is also increasing (Du et al., 2019; Milner-Bolotin, 2018; Richmond et al., 2017; Rinke, Gladstone-Brown, Kinlaw, & Cappiello, 2016; Terrazas-Marín, 2018; Wright, Balgopal, Sample McMeeking, & Weinberg, 2019) and much research is being carried out on a wide range of aspects related to both pre- and in-service STEM teachers. However, understanding STEM teacher learning in informal settings such as STEM centers, science centers, and museums remains an area less talked about in the literature. A challenge often mentioned for STEM teachers is that their environment and work are heavily dependent on technology while technology is constantly changing and evolving (Waight & Abd-El-Khalick, 2012). Not much is known on how informal STEM teachers progress in such

environments and how or whether this changing nature of technology enhances or hinders their learning.

The current literature on how STEM teachers progress is not quite clear as it is scattered throughout works on teacher training, professional development, teacher identity, and teacher perceptions and attitudes (e.g., Al Salami, Makela, & de Miranda, 2017; Faber, Hardin, Klein-Gardner, & Benson, 2014; McIntyre et al., 2013). By looking at past studies on teacher identity, Avraamidou (2014) calls for the need to carry out studies specifically on science teacher identity which are longitudinal and view teacher identity as a process which show how teachers develop in different contexts. Mewborn (2002) carried out a longitudinal study on an elementary mathematics teacher for a period of four years; ranging from when she started taking her mathematics methods class, up until the second year of her teaching. With the help of Green's (1971) explanation of belief systems and Dewey's (1933) reflective thinking which consists of openmindedness, wholeheartedness, and responsibility, Mewborn realized that over time, the study's participant identified, analyzed, and solved inconsistencies in her beliefs through reflective thinking. She was seen to shape her thoughts to resemble the ideal belief system laid out by Green (1971) which consists of a combination of different types of beliefs.

Carrier, Whitehead, Walkowiak, Luginbuhl, and Thomson (2017) studied two science teachers in a longitudinal project over three years which included their teacher preparation years and their first year of teaching at an elementary level. To do this, they started with three stages of student, teacher candidate, and teacher. Inside these three stages, they studied Gee's (2000) identity constructs which are nature (background

influences), institution (influences of institutions on identity), discourse (influences of conversations with others), and affinity (influences of communities). Themes that emerged which affected these identities of participants in their journeys from students to teachers were memories related to science and science instruction, STEM-centered program, experiences gained in the field, teaching in the first year, and opinions held on what good science teaching consists of.

STEM education initiatives in informal settings have many proponents because of their potential to enhance STEM learning without standard curriculum pressures (National Research Council, 2009; Peppler, 2017). However, informal STEM education is a narrower subcategory of STEM education in general, and this means there are even scarcer resources on how teachers develop their identities in such environments. Research shows that informal STEM settings benefit teacher professional development by improving their STEM literacy (Jackson & Mohr-Schroeder, 2018), encouraging them to try new teaching methods, and enhancing their classroom-relevant competencies such as creativity, social skills, and leadership (Terrazas-Marín, 2018). But longitudinal-natured studies which specifically show how teachers progress in such environments and how their identities are shaped are rare. Through semi-structured interviews with secondary school teachers who participated in informal STEM outreach activities with their students, Aslam, Adefila, and Bagiya (2018) realized that these activities provided teachers with opportunities to interactively and transformatively co-learn alongside their students and deeply reflect on their teaching practices which resulted in a strengthening of their own identities as STEM professionals. Adams and Gupta (2017) show that teacher candidates who work in informal science institutions progress and develop their

professional identities by using the informal settings' flexibility and opportunities to link practice to theory, develop improvisation skills, and imagine themselves in the future. The existing studies on teacher learning and progress in informal settings focus on pre or in-service teachers who have undergone or are currently undergoing formal teacher education and how being in informal settings can complement their skills for a formal educational setting. Whereas many teachers in informal settings are not required to have had formal training. Studies which do observe informal teachers who did not necessarily go through formal teacher education, do not necessarily emphasize teacher progress. Koch and Gorges (2016) studied several women STEM facilitators working in an informal setting who came from different educational backgrounds and interests. Although their work did not focus on how these facilitators developed as teachers, it did show how they had all experienced a level of professional growth and developed their STEM identities because of the STEM course they had taught. Their research participants mentioned that learning from the curriculum they had in hand, putting it into practice, and working in an encouraging environment had influenced them to continue work in STEM related fields by resuming to teach in the field or moving on to other STEM careers. Participants' confidence and interest in STEM was also reported to increase.

To address the substantial gap in existing literature where there is not much known on informal STEM educators' progress who have not undergone the usual teacher training others have undergone, this study set out to follow the natural progress of one such STEM teacher in her very first informal STEM class. This teacher is one of the authors of this study and will be from here on referred to as Najmeh (her first name). The study was

guided by this research question: What are the learning progressions of one STEM teacher in an informal setting?

3.1 Theoretical Framework

To answer our research question, this study uses the "Self-authorship" framework developed by Baxter Magolda (2004). Robert Kegan (1994) first developed the basis of this framework by breaking down the personal evolution of adults' meaning making into three stages of socialized, self-authoring, and self-transforming. In the first stage, one's environment defines them, and they constantly seek approval from others. In the second stage, one can assess others' opinions using their own views. This refers to one's capability to internally make meanings, as opposed to externally, when faced with various environmental and relational expectations. The last and rarest stage to reach is the self-transforming stage where one can look at all beliefs from the outside and be open to ideas.

Building on Kegan's (1994) work, Baxter Magolda (2004) created an identity development framework (see Figure 6) consisting of four stages (in three dimensions) which we will be using in this study.

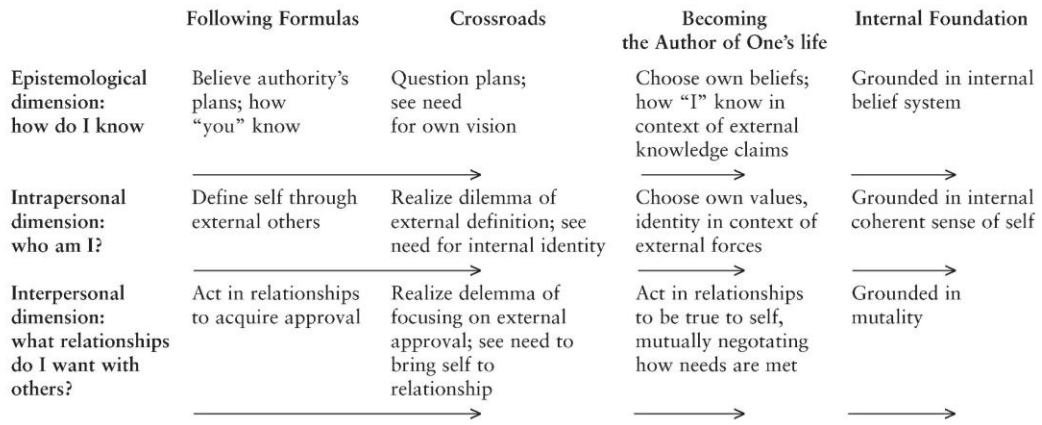


Figure 6. Self-Authorship Framework Adopted from Baxter Magolda's (2004) Study.

The first stage is the "Following Formulas" stage in which a person looks for external signals as guidance for actions and decisions and lacks an "internal voice". Or in other words, "external voices (those of others) in the foreground drown out [the] internal voice" (Baxter Magolda, 2009, p. 4). The dissatisfaction of this blind imitation or complete adherence to others' views, leads one to the second phase which is the "Crossroads" stage. In this stage, one realizes that they have ignored their own desires for too long. Constantly following others brings about problematic results and the need arises to include oneself in decisions as well as others. At this point, self-value gradually gains importance in what one believes in and does, and this slowly paves the way for the next phase. The third stage is "Becoming the Author of One's Own Life" and consists of one realizing that they can and want to create their own ideas. This also means that they now shape their own identity as well, along with their social relations. In other words, they are now the ones deciding for their lives. After experiencing this stage for some time, one can possibly move to the fourth and final phase which is the "Internal Foundation" stage.

In this stage, one finally feels as if they have control over their life and external factors as opposed to being controlled by them. The self-focus that exists does not come from selfishness, but it is through the comprehensive consideration and evaluation of others' viewpoints and relevant context that the last two stages appear in one's life.

The three dimensions of epistemological (how we know), intrapersonal (how we see ourselves), and interpersonal (how we create our relationships) contribute to this development. An older study on college students' epistemologies by Baxter Magolda (1992b) was also in line with this framework as it showed that students initially start out with an absolute knowing, where they believe all authorities say is true and certain. Then they move on to transitional knowing and realize that some knowledge is not certain, and finally reach independent knowing where they come to believe most knowledge is not certain. An even more advanced stage where students rarely reached is the contextual knowing stage where knowledge is evaluated based on the existing context. These stages of knowing can be seen as parallel to the identity development stages mentioned above.

Baxter Magolda (2004) initially developed the self-authorship framework to show how college students' identities developed throughout their college years. The various stories which have shaped this framework during and after one's college years (from ages 18 to 45) show how each person's journey can be unique and the strengthening of one's internal voice can happen at different ages and in different contexts (Baxter Magolda, 2009). This personal identity framework which has been able to support such a vast age range for adults has proven to be quite adaptable as it has been used for professional identity development (Hunter, Laursen, & Seymour, 2007; Nadelson et al., 2017) as well and for other groups such as college educators (Gunersel, Barnett, & Etienne, 2013).

When speaking of favorable collegiate outcomes, King and Baxter Magolda (2005) introduced three levels (initial, intermediate, and mature) of intercultural maturity which show how individuals learn to act and understand in interculturally appropriate ways. Later on, when studying possible enhancements of educator's experiences, intercultural maturity was again mentioned with each level of it corresponding to one of the self-authorship framework stages (Baxter Magolda, 2014). The initial level is in line with Following Formulas, the intermediate level corresponds to the Crossroads stage, and the mature level speaks of self-authorship.

These studies have also shown that people may follow different levels of progress throughout the stages based on the contexts they are in because of the various experiences they have. Here, as we are studying the teacher's natural journey without any formal external support, the stages of Following Formulas, Crossroads, Self-Authorship, and Internal Foundation (Baxter Magolda, 2004) will be used to analyze the data.

3.2 Method and Research Context

This study was carried out in the form of a single case study with a single unit (Yin, 2018). The unit of analysis is the teacher and the data gathered is related to a six-week reflection and teaching period at a STEM center in Ontario. At the time of the study, Najmeh was a 32-year-old PhD student in the field of Education with a background in Business. She had volunteered at this STEM center since July of 2017 and was then offered to teach a course in February of 2018. Her only teaching experience dated back to her teenage years when she had taught English to young children after her own school hours. During her volunteering period at the center, she had mostly helped with youth

robot-making, laser cutting, and coding classes which the center's director of Education taught. During this time, she became familiar with the teaching environment at the center, learned the kids coding software regularly used for the classes (SCRATCH), and used opportunities to show her graphic design skills which all led to the decision for her to teach her own course. Najmeh's STEM class was a four-session graphic design and game development course held in this informal setting over the period of five weeks (one session a week, with one week in between sessions three and four when no class was held) (see Table 2). During this time, she was in direct and constant contact with the center's director of education who, apart from teaching classes, spends a lot of his time developing the center's spaces, settings, and curricula to accommodate students from all age groups, especially ages 6 to 12. He is also one of the founders of this non-profit STEM center which was established in 2016. During most of our participant's classes, the director was more or less present in the class to monitor her teaching, give her guidance, and offer students complementary information when needed. This graphic design and game development course was a course catered towards ages 6-12 and had been previously taught by the director himself. As a result, the director suggested a number of graphic design software which could be used for the classes, but also gave the Najmeh freedom to choose other options. No lesson plan existed for what had previously been taught and expectations for course content were flexible, as long as some "graphic design" and "game development" were covered with a tangible final result to show the parents.

Table 2: Participant's overall final course layout

Date	Game element	Graphic design topics covered	Coding/SCRATCH topics covered	Other topics covered
21/02/2018	2D character designed in Gravit	Drawing shapes, coloring, different selection tools, layers, editing path, etc.	Simple looks codes (costumes), sounds (say), control (wait), events (green flag or if x key is pressed), etc.	Imagination, problem solving, reasoning
28/02/2018	2D character designed in Piskelapp and 3D character in Magicavoxel	Piskelapp: drawing shapes, symmetric drawing, cut/copy/paste, gif, etc. Magicavoxel: different brushes (attach, erase, and paint for each), eye dropper, templates, canvas size, etc.	Simple motion codes (moving, go to), More complicated controls (if/then, repeat), etc.	Collaboration, problem solving, reasoning, perspective taking/empathy
07/03/2018	Background designed in MyPaint with a graphic tablet	Shortcut keys on tablet, different brushes, pressure sensitivity, tracing images, layers, scrap page, etc.	Similar to first two sessions plus variables and clones	Tracing/modeling, problem solving, reasoning
21/03/2018	Character (picture of themselves in SCRATCH)	Understanding the green screen concept, using magic wand and eraser in SCRATCH to cut their own picture out	Modifying existing codes, repeat until, operators, more complicated looks, sound, and motion codes	Imagination, bodily expression, mathematics

Since Najmeh's progress was important to us, we coded the data based on challenges she was facing and solutions taken up for those specific challenges throughout the sessions. Inside these categories an inductive approach was taken using open and axial coding (Creswell, 2007) to find emergent patterns. During this process we realized our data was in line with Baxter Magolda's (2004) self-authorship framework and decided to reanalyze our data with it.

To better adapt this framework (Figure 6) to our study, two minor modifications were made. First, in the Following Formulas stage and at the epistemological dimension, "Believe authority's plans; how 'you' know" was changed to "Believe authority's plans

and other knowledge sources; how 'you' know." And in the same stage, at the interpersonal dimension "Act in relationships to acquire approval" was modified to "Search for or act for approval in relationships." Then, a code was created for each of the dimensions of each stage (e.g. believe authority's plans and other knowledge sources, define self through external others, search for or act for approval in relationships, etc.), resulting in 12 a priori codes (Appendix F). We then went through our available data using these codes while also marking each piece of coded data in our overall time frame (Figure 7). For example, "I spent much of today again playing around with Mypaint which I told [the director] I want to use for next session…" (March 3, 2018) was given two codes. The first code was "Choose own beliefs" because Mypaint was a software Najmeh had personally decided to use and was different from the software initially suggested to her by the director. And the second code was "Act in relationships to be true to self, mutually negotiating how needs are met" because Najmeh normally looked for approval from the director, but here she showed that she was the one who strongly promoted the use of this software to be used.

According to Lincoln and Guba (2013), data triangulation, peer debriefing and member checks, and process and data audits were used for trustworthiness. For triangulation, Najmeh's journal was used alongside her designed lesson plans, and her artifacts (designed characters, backdrops, coding and visuals of games, etc.). A screenshot of the mentioned data sources imported into Nvivo can be seen in Appendix G. Before the analysis, the choice of method, and after the analysis, the codings were sent to an impartial colleague for peer debriefing. Findings were discussed with Najmeh at two stages to confirm accordance of our work with her experience. The same colleague who

had supported us for peer debriefing and was well aware of our methodological approach also performed our process and data audits and provided us with continuous feedback throughout the work.

The content and teaching methods used by Najmeh make up the epistemological dimension of the framework, the way she sees herself as a teacher is the intrapersonal dimension, and her relationships with the director, students, and students' parents make up the interpersonal dimension of the framework. We would like to acknowledge that this framework is usually studied with the help of many interviews and over long periods of time whereas our study only covers a six-week period. However, as mentioned above, our data pointed us towards this framework and we clearly saw value in assessing this compatibility.

3.3 Findings

We found that Najmeh's progress in our study shows that it is in line with Baxter Magolda's (2004) self-authorship framework. As indicated in Figure 7, she starts clearly in the Following Formulas stage and gradually moves towards self-authorship in a nonlinear way, with the most distinct change visible over time in the epistemological dimension. A total of 125 codes were created; 58.4% of the codes related to the epistemological dimension, 15.2% referred to the interpersonal dimension, and 26.4% referred to the intrapersonal dimension. The number of references found for each stage of the framework can be seen in Appendix H, and for each code in Appendix F. A screenshot of the coded data can also be seen in Appendix I.

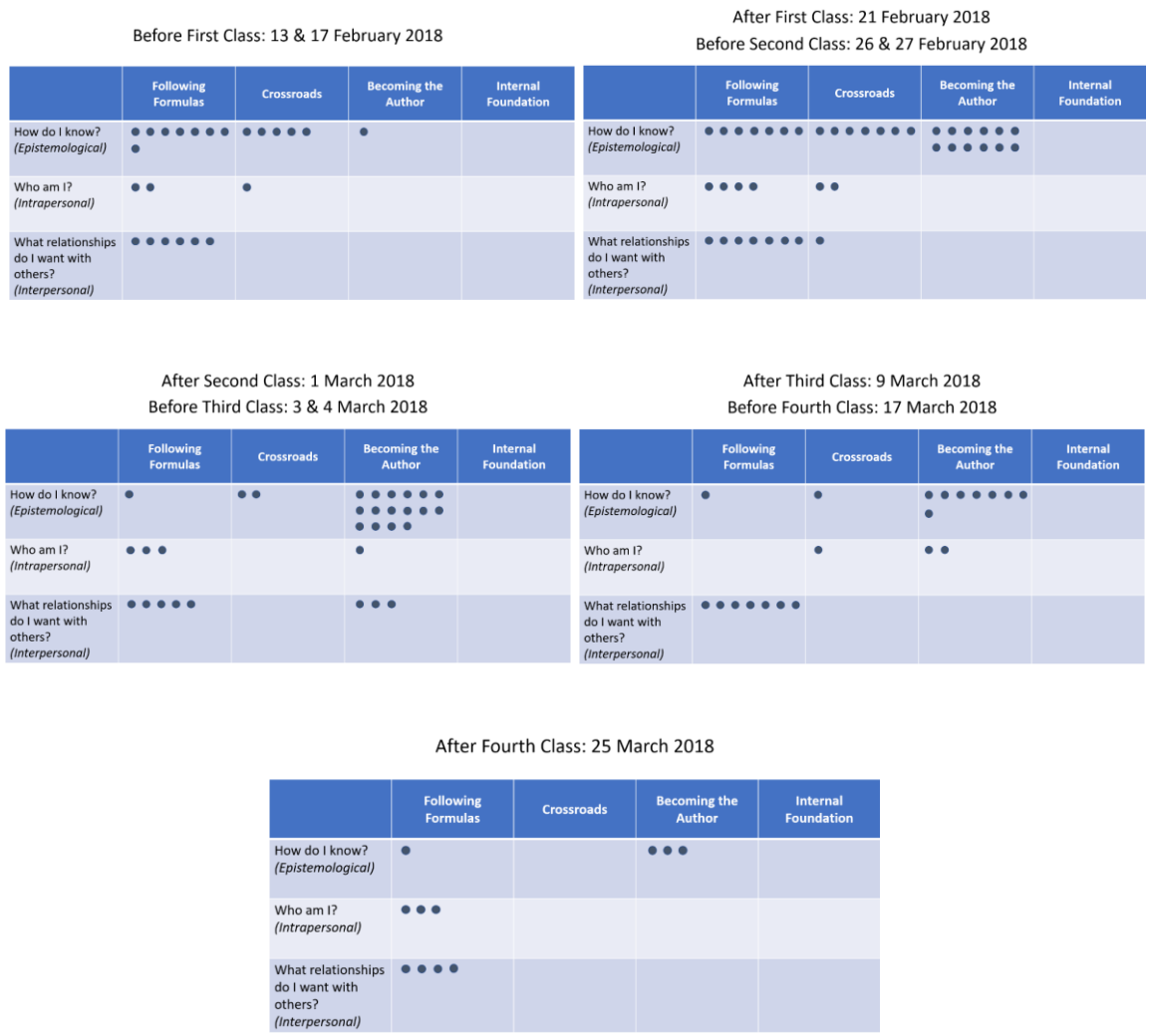


Figure 7. Visualization of Codings in Framework.

3.3.1 First Class

Najmeh's journal shows a complete lack of internal voice in the initial entry, which starts improving substantially in the following entries. She was knowledgeable in the contents of the course, but it was the first time she was going to design and teach a STEM class. She asked the director for some ideas in an email and received a reply. In her initial journal entry, she noted "Based exactly on his email, I started to create a lesson plan"

(February 17, 2018). Once finished, she wrote “Even though he [the director] didn’t ask, I showed it all to him and we chatted about it online” (February 17, 2018). Apart from her believing in the director’s knowledge (epistemological), it was seen that she showed the director her work in hope of receiving approval (interpersonal) even though it was not asked of her.

Before the class, she also wondered about herself as a teacher (interpersonal) by writing “What if I’m not what he [the director] expects me to be? But I should be because he has seen me in class and so if he thinks I can, I should be able to” (February 17, 2018). She included an idea of her own but left it out from the lesson plan to ask for the director’s opinion on it. This complete following of others and adherence to imagined or real expectations continued until the first class had been held. The positive experience of the first class along with the approval and support she received from the director, pushed her to give more weight to her own content knowledge and ideas for the second class.

3.3.2 Second Class

Before the second class, she showed signs of being in the Crossroads stage by revising the next session’s lesson plan with small ideas of her own in a red colored font and with question marks which she did not check with the director this time (see Figure 8). This shows that she sees the need to bring in her own views without necessarily checking them with an authority, but still they are in red and accompanied with question marks which show her lack of confidence to act on her views without approval.

Designer name? how much will you charge? Write in first person? I am a banana with an umbrella because I'm afraid I'll get wet in the rain?

People are scared of math? Shall we make a game for them to reduce their tension? How can we do that? Background, character, sounds, etc. search and take notes.

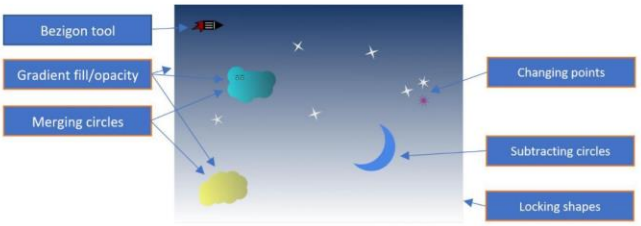
Take some things which people don't understand and explain them, like global warming, the sky, a healthy one, a sick one, how about the sea

Have students write on a piece of paper a character or a backdrop they would like to have in a game. They should either draw it or describe it. For example, one can say I like an alien with blue wings that is shy and has a big foot. Then everyone puts their papers in a pile. Now tell students, they are going to be professional designers for someone else. They just got an order and they are going to design the order for their customer in Gravit. Every student takes an order from the pile, opens it up and tries to make the character written on the paper, or something that matches it. Obviously, if someone takes out their own name, they put it back in the pile and take another one. Once finished, save all in one spot on the network with the name of the order, and everyone can go see what they ordered turned out to look like. They can bring any character they like for future SCRATCH projects.

Next, take a minute to imagine a different sky, if your game was up above our heads, beside the clouds, stars, and moon, what would your sky look like? (or link this to the last exercise if there is not enough time, meaning, have students order a sky!)

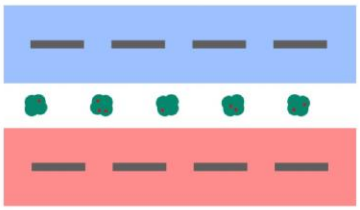
Go in to Gravit, enter size of SCRATCH backdrop (480*360 pixels) and create a backdrop. Save as svg and import into SCRATCH as backdrop. Also save on network. Students can use each others' designs as well.

Example, new design concepts in green.



General tools used: Selection, drawing different shapes and lines, etc.

If time left?, Create this simple background in Gravit (ok to go back to Gravit?) as well. Both roads and marks are rectangles, bushes and berries are circles. Also use distribute evenly option.



If there is time left, take the sky backdrop into SCRATCH and create this interactive backdrop:

Figure 8. Najmeh's Lesson Plan in the Crossroads Stage.

Right before the second class she decided firmly to bring in her own idea as a centerpiece which shows her need to include her own knowledge. But at the same time, her own idea was the same idea that she had proposed to the director before the first session and had gotten positive feedback on. She wrote "…this time I'll be doing the activity I initially

proposed in the last page of the lesson plan which [the director] said he liked" (February 27, 2018) which illustrates a tendency to epistemologically move towards self-authorship and trust her knowledge while still heavily relying on epistemological, intrapersonal, and interpersonal approval and guidance from other sources. Her constant look-out for satisfaction among students and their parents also showed this need for approvals. For example, she mentioned "In the end [the student]'s family came in and spoke to the director and wrote down the names of the apps we were working with. They seemed to like the class and the software we were working with" (March 1, 2018).

3.3.3 Third Class

Similarly, gradual change can be seen as we move forward throughout the weeks. For the third session, Najmeh decided on new content and a new software which was different from what the director had suggested. The director had purchased graphic tablets after the first class and asked Najmeh to add the use of these tablets to one of the sessions. He also suggested she use the tablets with the Sculptris software, to create 3D characters. The teacher disagreed because she noticed that her students had already been making characters for the last two sessions and wanted to provide a new experience for them, so after careful consideration of a handful of software, she proposed to make a backdrop or a different element for the third session using a new software (Mypaint). The teacher started to recognize and communicate what she wanted to teach and do in class as opposed to what had been suggested to her so far (epistemological). Also, for the first time, she was confident in herself (interpersonal) and was negotiating with the director

for her decisions (interpersonal) which were the strongest signs of progression through the framework seen up to this point.

3.3.4 Fourth Class

For the fourth session, again she inserted new ideas in the lesson plan but without any question marks or red colors. She did not consult the director regarding her plans and wrote both in her journal and lesson plan in a more assertive manner compared to her initial entries. She also expressed she is more comfortable to joke around with students and have a good time. Instances like these point to her progress towards self-authorship in the epistemological and intrapersonal dimensions as she starts trusting her identity as a teacher and her decisions on what to teach. This level of self-authoring was seen most in the epistemological dimension towards the end. However, when it came to relationships and other people's expectations, she was still constantly concerned about approvals and how her actions were seen by the director, students, and parents, even after the last class. Figure 7 shows a visual representation of how during the weeks, the codings move through the identity stages of the framework.

3.3.5 Interweaving and Interdependence of Dimensions

Some data adhered to the framework but were not easily codable into one specific section of Figure 6, or they simultaneously adhered to different sections of the framework. As Baxter Magolda (2004) had also concluded, this showed a clear interweaving of the three dimensions of the framework. The interpersonal code relating to the following formulas stage titled "Search for or act for approval in relationships" overlapped with 16

epistemological and 14 intrapersonal codes. In the initial sessions, Najmeh only looked to teach the director's suggestions or what he had approved of. This shows her beliefs about knowledge and herself as a teacher depended completely on her relationship with the director. This dependence of the intrapersonal and epistemological dimensions on the interpersonal dimension stayed visible throughout all the sessions (See Figure 7).

In her second entry once again, she showed how she made her teaching decisions based on the feedback she received from the director:

> Then, although I had not initially planned this out from last week, since [the director] gave me good feedback on the lesson plan regarding the order giving [activity] section, I took the liberty of incorporating imagination a bit more here as well so I took them [students] to sit in a corner away from the computers and did an imagination activity, where they closed their eyes and imagined a place where rain falls from purple and orange clouds, but the raindrops are not water. (February 21, 2018)

Moving forward she started to realize what kind of a teacher she wants to be, but she was still burdened by the presence of others when they are there.

> I feel more confident now when teaching. I think. Or maybe I'm saying this because the session on March 4th, I was alone more. Holly was not there as a volunteer, and [the director] came in late and would go and come back more than usual. (March 9, 2018)

Apart from her relationship with those in the center, her relationship with the students and parents also shaped how she decided to act and see herself as a teacher. The following quote refers to when Najmeh believed in what she had taught and how she had taught it, but she was still afraid of a student's father's judgement and shaped the rest of her actions differently because of the parent's presence. This separation of beliefs and actions is also a characteristic of the crossroads stage:

> So when he [student's father] came in at around 6:15pm, my activity was done, and they were simply playing around with the code and designs so I was afraid that he'd think we were simply wasting time and not doing much. So, I decided to go to the students' sides one by one to see what they are doing and try to help them expand their ideas and I hope it didn't look bad. (March 25, 2018)

The very last sentence of her journal after the last class, points to the link she saw between her being a good teacher and what she felt the students thought: "Overall I'm satisfied with the class and myself as a teacher and I know the students were too" (March 25, 2018).

As mentioned, there were many instances throughout our data where the epistemological and intrapersonal dimensions depended on the interpersonal, but we were also able to occasionally see the opposite. When the graphic tablet was added to Najmeh's agenda is where the interpersonal dimension depended on the other two dimensions. After she was given the tablet, she downloaded a number of software and spent many hours testing them out, while also learning to work with the tablet herself. Once she had gained enough knowledge in the area, she gained her own opinion on what she wanted to teach, how she

wanted to teach it, her reasons for her choices, and also what software she thought was best for the students. This epistemological and intrapersonal progress was what empowered her to disagree with the director and negotiate her requests and beliefs instead.

These instances all reinforce the interconnections of dimensions and show how improvements in one can affect the other.

3.4 Discussion

This study expands the literature on informal STEM teacher progress by recognizing its adaptability to the self-authorship framework. Different from research that studies teachers' experiences while relating them to a specific teacher professional development or teacher education program (Al Salami et al., 2017; Faber et al., 2014; Glavich, 2016), this study observes the natural pathway a novice informal STEM teacher follows in the environment she is placed in without any preplanned support. As mentioned above, the observed development resembled the self-authorship framework (Baxter Magolda, 2004). This framework has a complex and cyclical nature, so moving through the stages does not necessarily translate into following a linear path (Baxter Magolda, 2008).

This is seen in this case (see Figure 7) as Najmeh clearly starts in the Following Formulas stage but constantly shows elements of moving forward up until the Self-authorship phase while simultaneously moving back to the initial phase. The existence of a code related to a stage does not necessarily indicate that the participant is in that stage. Successfully reaching self-authorship requires doing so in all three dimensions and this

did not happen for Najmeh which is understandable given the short duration of this study and the time needed for one to grow into self-authorship. However, we speculate that the slow but existing progress and adherence of data to the framework indicate that if this research were to continue to study Najmeh's progress in her next classes, she would have moved into the self-authorship and internal foundation stages over time.

Baxter Magolda's (1992a) initial study on college students showed the question of "what and how one knows" is more dominant for those in the initial phases of the framework. But this same study also guesses that this was because of the nature and framing of the study at that point in time. As our case duplicates this finding, we see three potentials hypotheses. First, possibly those in the initial stages are actually in general more occupied with the epistemological dimension; second, it can be a result of the Najmeh focusing on the epistemological dimension because of the curriculum designing task she had taken on, or third, there may have coincidentally been more data on this dimension for us to explore.

Similar to Baxter Magolda's (1992b) college students, Najmeh started as an absolute knower (believing in absolute forms of knowledge) and gradually moved towards independent (believing in oneself along authority) beliefs. Issues arising from blind following lead to a quick stage change at first, but it is not permanent as moving into self-authorship and contextual knowing requires much more time. We believe with the passing of time, Najmeh would have also moved towards contextual beliefs about knowledge where one considers the context, expert knowledge, and self-knowledge simultaneously when making decisions.

The self-authorship framework also uses Kegan's (1994) notion of the subject-object relationship. According to Kegan, an *object* is an element which we can stand apart from and reflect on while a *subject* is something which is part of us and we have no control over. In this study, Najmeh showed that in the beginning of her journey, she saw her teacher role as a subject and as a subcategory of the director and others' expectations with no room for change. Her role was part of who she was, therefore, it was fixed. Over time, she was able to move her role from a subject position to an object one, where she was able to look at it from the outside, reflect on it, and influence it.

The importance of continuously looking for and receiving approvals and supports was seen in all the developmental stages of the framework until the very last entry of the journal. The three dimensions are deeply interwoven with the epistemological and intrapersonal ones specifically reliant on the interpersonal dimension. It is external expectations and the approvals and support that Najmeh received from others (students, director, and parents) that concern her while at the same time giving her courage to move forward and make decisions about what to believe in and what to do. We believe this is in line with literature that emphasizes the importance of collaboration opportunities (Fulton & Britton, 2011) and mentoring programs (Andrews & Quinn, 2005) for novice STEM teachers as they are able to provide support and nonthreatening feedback to teachers (Brighton, 1999).

Another point which became evident in this study and can be fruitful for teachers of all subjects is that much of the progress that took place towards self-authorship was during the Najmeh's involvement in the curriculum designing process. This process provided much opportunity for reflection and self-reflection which are closely linked to the

intrapersonal level of self-authorship (Baxter Magolda, 2004). This also contributes to studies which call for the involvement of teachers in curriculum creation for the purpose of teacher professional development. Ball and Cohen (1996) believe that when a curriculum is developed/designed by a teacher with a focus specifically on *enactment*, it will enhance teacher learning because of the following interconnected domains it covers. First, what teachers think about their students and what their students bring to the class; second, what teachers think about the material and how they use this understanding; third, how teachers customize the material for their students; fourth, how the class environment affects everything; and fifth, how teachers' views on broader contexts influence the curriculum. Curriculum development is also promoted for teacher professional development in the form of group activities and in networks (Coenders, Terlouw, Dijkstra, Pieters, & Pieter, 2010; McFadden & Roehrig, 2017). However, this study points to the benefits of individual curriculum development as well which is known to increase teacher confidence and reflection (Valli, 1992). In Najmeh's case, this individual curriculum development helped move the teacher through the self-authorship identity stages with the help of constant reflection.

Similar to the positive effects of participating in curriculum design, we believe the technology-based nature of the subject which Najmeh taught also created many opportunities for her to reflect on her work and be pushed towards a quicker progression through the self-authorship framework, especially in the epistemological and intrapersonal dimensions. As pointed out at the beginning of this paper, technology is constantly changing, and this means much effort is required if teachers are to stay up to date on the newest and most appropriate options available. For example, when the center

director added the use of graphic tablets to Najmeh's agenda, this was quite a big challenge and modification for her as she had already preplanned her sessions. She put quite a lot of time and effort into studying available software and choosing the proper one. This process entailed much reflection on herself as a teacher, her students, and her practice. Such changes are very common for those who teach technology-based subjects or regularly use technology in their teaching practice. If educators are to be adaptable, deliberation will be inevitable, and reflection is clearly critical in teacher professional development and progress (Postholm, 2008; Wang, 2017). This technology-enhanced learning which took place for Najmeh is very well in line with literature that studies the technology selection process that teachers go through and the criteria they consider when doing so. For example, Ocak and Baran (2019) studied primary and secondary school science teachers and saw that they considered adaptability to science content, students' needs, and the features of the technology during their selection process. Haugland (1999) also points out 10 criteria for technology selection for young children which include age appropriate, child in control, clear instructions, expanding complexity, independence, nonviolence, process orientation, real world model, technical features, and transformation. Choosing what software to use (and how to use it) among the myriad of available options is no simple and straightforward task for the teacher and will require much deliberation which can help enhance teacher learning and progress. We will also add that a well-known barrier to technology use is a negative belief or attitude towards it (Mama & Hennessy, 2013). The fact that Najmeh was a STEM teacher meant that she already had a positive attitude towards technology use and welcomed the changing nature of it which led to more thoughtful and openminded reflections. Najmeh also had

flexibility and enough time to indulge in these reflections because she was an informal STEM teacher who was not under the pressure of carrying out a specific curriculum.

3.5 Conclusion

The importance of STEM education has inevitably led to a range of studies on STEM educators. Informal STEM settings which are widely used to generate motivation in students (Aslam, Adefila, & Bagiya, 2018; Ayar, 2015) also call for the study of educators specifically in such environments. Because of existing research and evidence relating to teacher development pathways, there is a better view of those coming to the classroom through a standard pipeline as opposed to educators who have not experienced such a conventional journey to STEM teaching. This study set out to follow the natural progress of a novice STEM teacher who had not undergone any teacher education. The resulting data pointed us towards Baxter Magolda's (2004) self-authorship framework. Although this framework was developed to explain the experiences of college students from their early college years until after their studies, it also showed a reasonable compatibility with Najmeh's experience. This resemblance does not come as a surprise to us as they both have one's natural progress and identity development in mind. In line with this study and with other studies which have linked the self-authorship framework to other demographic groups (Gunersel, Barnett, & Etienne, 2013) and to professional identity development instead of personal identity development (Nadelson et al., 2017), we suggest further research should be done to study more STEM teachers who have similarly not undergone teacher education to see if the same results emerge, in addition to

teachers who have undergone such education to see if those who have had a standard support system follow a similar pathway or not.

The adaptability of the self-authorship framework to our informal STEM teacher's progress, as well as to college students, university science students, and college educators (Baxter Magolda, 2004; Gunersel, Barnett, & Etienne, 2013; Nadelson et al., 2017), signals the development of human nature in general. This means skills linked to the stages of self-authorship and internal foundation could come in handy for teachers regardless of the subject they teach; skills such as being able to have one's own voice when it comes to deciding what to do and how to act in social relations. Further research can also shed light on how this framework would work for teachers who have went through the framework for one subject but start teaching a different subject for the first time. For example, if a STEM teacher reaches the self-authorship or internal foundations stage in their work, and later they decide to start to teach History, will the stages have to be gone through all over again? Or will it be different this time because of some of the mentality which was previously shaped when the teacher was teaching STEM? Is any part of this framework transferrable?

We would like to acknowledge that our study was not free from limitations and challenges. As our initial intention was not the analysis of our data based on the self-authorship framework, our data and the framework do not have an ideal match. For example, some days Najmeh's journal entry was very short, offering us limited information on her thoughts and the different dimensions of the framework, while some other days entries were much longer with plenty of room for insight and this caused an imbalance in the amount of data available to code by date. The timeline of the study was

also short for an identity development study and although all data sources were used and coded, the journal data source became dominant. This study advances the literature on the informal STEM teachers' identity development and progress by recognizing its compatibility with the self-authorship framework. It also stresses the importance of teacher support initiatives which involve collaboration, mentoring, and curriculum design which can help support an informal STEM teacher in their journey.

3.6 References

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Chapter 4

4 The Aspiring Teacher Entrepreneur's Competencies and Challenges in an Informal STEM Environment

Teacher entrepreneurship is a new and evolving area of research which has gained growing attention over the past 15 years, especially because of the interactive and innovative educational environments it nurtures. For the purpose of this study, we consider teacher entrepreneurs as those who are entrepreneurial in their teaching and teaching-related work (Oplatka, 2014). Such teachers can be categorized as *social entrepreneurs* who carry out "a process involving the innovative use and combination of resources to pursue opportunities to catalyze social change and/or address social needs" (Mair & Martı´, 2005, p. 3). According to Keyhani and Kim (2020), teacher entrepreneurs are socially motivated individuals who are dedicated, proactive, risk tolerant, knowledgeable, innovative, resourceful, opportunity-minded, visionary, collaborative, present in their work, and self-improvement oriented.

Although all teacher entrepreneurs do not possess all of the mentioned competencies and traits, it is well known that entrepreneurial abilities and competencies increase with experience. Possible reasons are that experience can provide a relevant and practical basis for teachers to learn from (Bulger et al., 2016), bring about higher levels of pedagogical and content knowledge (Amorim Neto et al., 2017), along with knowledge on entrepreneurship itself (Mikkonen et al., 2018). It is said that through experiential learning, a nascent entrepreneur learns to become more entrepreneurial while going

through the process itself (Politis, 2005). The competencies they display differ in rank and order (RezaeiZadeh et al., 2017), and vary based on the stage of the entrepreneurial process they are in (Bygrave, 2010; Moore, 1986).

However, to date, little research has been carried out on nascent teacher entrepreneurs to understand how they exhibit entrepreneurial competencies and what challenges they face in designing and implementing innovative learning experiences such as STEM activities which are well-known for the level of collaboration and technological interaction they require. In this study, we follow an aspiring teacher entrepreneur's first STEM teaching experience to understand the entrepreneurial competencies they did or did not display and how the informal STEM environment they were in, affected their display of such competencies. This teacher is one of the authors of this study and will be from here on referred to as Najmeh (her first name).

4.1 Theoretical Framework

4.1.1 Teacher Entrepreneurship

In *A Systematic Literature Review of Teacher Entrepreneurship*, Keyhani and Kim (2020) list 12 competencies and traits which have been referred to in connection to teacher entrepreneurs in relevant literature. As mentioned above these include socially motivated, dedicated, proactive, risk tolerant, knowledgeable, innovative, resourceful, opportunity-minded, visionary, collaborative, present in their work, and self-improvement oriented, which we will explain below.

Socially motivated usually speaks of the teacher entrepreneur's end-goal which is to reach some level of social value (Sanchez, 2014). This value is either at a classroom level such as meeting students' individual needs or benefiting disadvantaged students (Bills et al., 2015), or at a higher level such as policy change (Hess & Finn, 2007). Dedication refers to teacher entrepreneurs' feeling of responsibility for students (Oplatka, 2014) or their personal qualities such as persistency (Borasi & Finnigan, 2010) and tenacity (Maranto, 2015). Proactive educator entrepreneurs are enthusiastic individuals not constrained by common challenges (Bulger et al., 2016) who also adapt or bend rules to tackle the problems they face (Amorim Neto et al., 2019). They take calculated risks (Martin et al., 2018) by testing new technologies and innovations in their classrooms (Berry, 2013a) and often risk their money, reputation, and time (Schimmel, 2016). Teacher entrepreneurs have shown to be knowledgeable in relation to entrepreneurship (van Dam et al., 2010) and teaching related elements such as contents, pedagogy, and students' backgrounds (Amorim Neto et al., 2017; Berry, 2013b).

Innovation can relate to any aspect of their work such as the use of new teaching methods like differentiated instruction, experiential (Dennis & Parker, 2010) or technology-enhanced learning (Borasi & Finnigan, 2010), or by standing up to the status quo (Cochran-Smith et al., 2018) and rebuilding organizational structures in new and better ways (Maranto, 2015). They acquire and manage the resources they need themselves, for example, through crowdfunding (Bulger et al., 2016) or strategic partnerships (Martin et al., 2018) and are constantly on the lookout for opportunities (Wilson Kasule et al., 2015) to create the social values they have in mind. Such opportunities quite commonly are dysfunctions and crises which have been turned around (van der Heijden et al., 2015).

Their strategic vision spans across their classroom walls and guides their work similar to ideologies (Leffler, 2009). They value collaboration immensely both for themselves and their students and continuously have a presence in their work, by reflecting (Keddie, 2017) and adapting (van Dam et al., 2010), or by improvising (Borasi & Finnigan, 2010) and relying on their instincts (Nash, 2014). And finally, they are self-improvement-oriented, meaning they are attracted by personal achievements and actively seek professional development and growth (Shelton & Archambault, 2018).

4.1.2 Novice STEM Teacher's Professional Identity Development

In this study, we also use Baxter Magolda's (2004) identity development framework because our previous work (2019) showed that the professional identity development of the investigated teacher in this study had aligned well with the mentioned framework (Figure 6). This framework which is referred to as the self-authorship framework consists of four stages which are presented in three dimensions. In the first "Following Formulas" stage, a person seeks external guidance and support for what they are doing and the decisions they make without having a voice of their own. Over time, the lack of a personal say and the unquestionable following of others helps push the person into the "Crossroads" stage where this problem is recognized more knowingly. Questions develop and the need to include and value oneself increases and one starts making changes. The third stage which is "Becoming the Author of One's Own Life" entails following up on the need to create and have one's own ideas which can shape the person's identity and relationships. The final stage which comes after being in the fourth stage for a long period of time, is the "Internal Foundation" phase where one senses they

have control over their life and can negotiate, evaluate, and affect the external factors which they previously adhered to without question. These four stages are placed in three dimensions of epistemological, intrapersonal, and interpersonal. The epistemological is concerned with how we know, the intrapersonal related to how we see ourselves, and the interpersonal is linked to how we create our relationships.

4.2 Method

4.2.1 Teacher Participant

In this study, we followed a volunteer teacher (Najmeh) in her 30s for a 6-week period in which she designed and taught her first STEM course in a non-profit STEM center in Ontario to young children. Before this stage, Najmeh had been volunteering at the center and observing and helping with the implementation of other courses for about seven months. In February of 2018, the center director whom she had been closely in contact with over the duration of her presence at the center, noticed her graphic designing skills and asked her to teach a graphic design and coding course to young children. Her previous teaching experience was limited and dated back to her teenage years when she was an English language teacher at a local language institute. Her pedagogical and classroom related knowledge had been developed respectably through her experience volunteering at the center and through her 18 months of graduate-level studies in the field of education. However, since this was the first time, she had the sole responsibility of preparing and holding the course, she was clearly considered a novice teacher.

The participant also held a master's degree in Entrepreneurship and was very well acquainted with the concept through her studies and work experience. According to her own account, she had been part of many entrepreneurial projects in different settings before, she had learned to be entrepreneurial herself, and strived to be an entrepreneur in all work that she took on. Previous entrepreneurial experiences (Minniti & Bygrave, 2001), aspiring to be an entrepreneur (Farmer et al., 2011), and intending to act entrepreneurially (Ajzen, 1991) are all very good predictors of entrepreneurial behavior. As a result, we believed Najmeh could be considered a nascent teacher entrepreneur.

4.2.2 The Study

In this study we carried out a single unit case study (Yin, 2018). Gathered data included the Najmeh's journal entries, lesson plans, and artifacts (graphic designs, activity sheets, slides, etc.) related to the 6-week period of this study and in relation to the designed and carried out course. At first, the entrepreneurial competencies and traits mentioned were used as codes to analyze the data with. During and after the coding process, it became evident that the patterns and quantities of entrepreneurial competencies exhibited by Najmeh did not portray the meaning behind the data and a more in-depth study of her behavior, and reflections was required to explore the quality of each competency.

Therefore, we went through the data separately for each competency to understand how they were or were not displayed and what benefits or challenges the informal learning environment had for Najmeh. To complement our understanding through this process, we constantly referred to Najmeh's progress through the self-authorship framework (Kim & Keyhani, 2019) for additional guidance. The three data sources mentioned above were

used for triangulation, and the authors met weekly to discuss and combine their separate findings on the competencies. Peer debriefing and audit trail were also used for trustworthiness (Lincoln & Guba, 2013) with the help of an impartial colleague at two stages of the work.

4.3 Findings

4.3.1 The Aspiring Teacher Entrepreneur

4.3.1.1 Socially motivated and dedicated

Najmeh showed much dedication and social motivation in her work. Her dedication was clearly seen through the excessive amount of time she spent designing the short four-session STEM course. The overall and finalized outline of the course can be seen in Table 2 which involves graphic designing and coding of game elements.

The course had been held at the center before. However, no documentation existed from the previous class as a guide to work with. Najmeh felt responsible for rectifying this issue by creating and documenting a lesson plan which she shared with the director to ensure future teachers can hold high quality courses and future students can benefit from them. After the fourth session, her lesson plan had been edited at least six times (Figure 9).

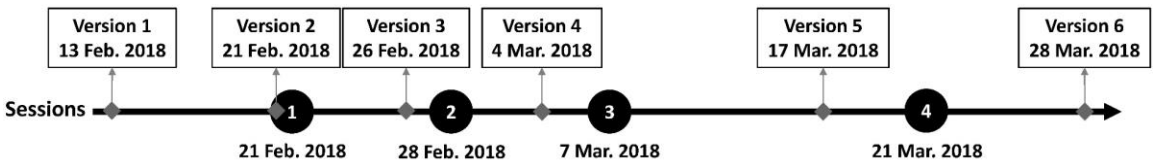

Figure 9. Participant's Lesson Plan Versions

Once she had finalized the sixth version of her detailed lesson plan (see Appendix J), she sent it to the director to make sure future students would also receive a well thought out training (March 25, 2018). However, despite these instances of responsibility and determination, we believe most of this dedication, especially in the beginning days, can be attributed to the teacher being in the following formulas stage of the self-authorship framework where she constantly sought stakeholders' approval (Kim & Keyhani, 2019). The following journal entry depicts both sides of this dedication very well:

> I spent a whole day from morning till night to come up with just the base of the 4 lessons, each teaching something different, and I tried to include in the lesson plan details that would prove the different skills I'm working on so when I show [the director], he'll have comfort in knowing exactly what I'm planning on doing. (February 17, 2018)

Her social motivation at both classroom and beyond classroom level was visible and genuine. At the lower level she showed concern for the course content and delivery methods to meet students' individual and overall needs. For example, once she became more acquainted with her students' personalities and interests, she refined her classroom efforts to make sure students were learning as much as possible. In the fourth session, students were to import and integrate their own pictures into a game and add their own

choice of codes to their pictures (see Appendix J). In a journal entry referring to this activity, Najmeh noted “Mark likes the same codes like turning things around in circles so if I’m not careful he’ll always do that and not explore new things” (March 25, 2018).

She also felt obliged to choose and design course content in a way to ensure her students were exposed to a wide range of possibilities and received a high-quality education. In addition to the software initially chosen for the course, she installed three new software (Gimp, Krita, and MyPaint) and learned to work with them all (February 27, 2018), just so she could choose the best option for her students in the third session which was modified to incorporate newly purchased graphic tablets. This concern of hers was in fact strong enough to make her disagree with the center’s director for the first and only time during her work. The director had suggested she use a 3D graphic design software named Sculptris, to have students create a character using their graphic tablets. However, Najmeh believed the students had already designed characters twice before in sessions one and two, and they required exposure to a different type of designing. Therefore, she disagreed and suggested students create a background design by tracing an existing image using the software MyPaint which she had recently learned. The director agreed to this as well and had the mentioned software downloaded on the students’ computers.

As her professional identity development was in its early stages, overall, epistemologically she placed high value in what the director said and interpersonally, she depended on his approval in their working relationship (Kim & Keyhani, 2019). But for this session, when it came to provide her students with a high-quality education, she had advanced her own knowledge (epistemological), gained a certain level of confidence (intrapersonal), and was willing to disagree with the director (interpersonal). Najmeh, as

a teacher, also showed her social motivation at a level beyond the classroom by ruminating on ways to expand her course content to include environmental issues to introduce her students to authentic problems such as reducing plastic bag use in households, although most of these ideas did not turn into reality.

4.3.1.2 Innovative and proactive

Najmeh was very proactive throughout her course development and implementation. After each session she revised the next session's lesson plan to include new and better content. For example, Figure 10 shows how the contents of session two were modified after session one was held.

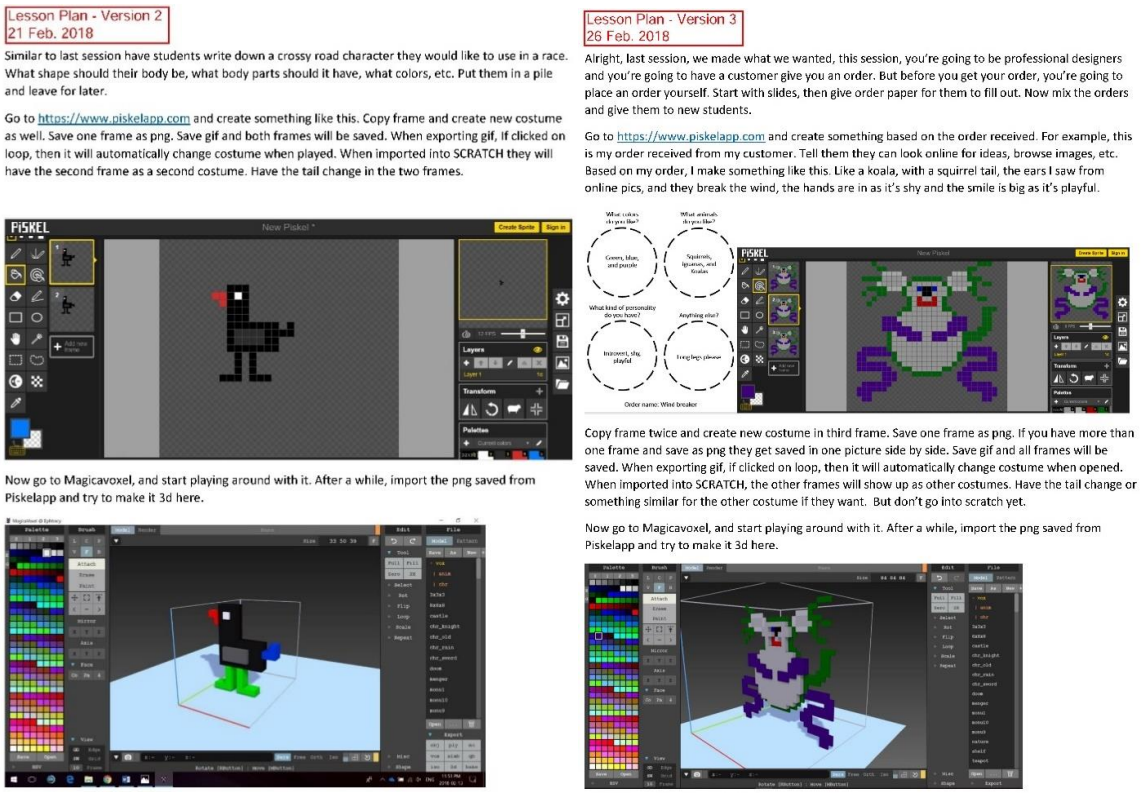

Figure 10. Session Two Contents in the Second and Third Versions of the Lesson Plan. Version 2 on the left side was designed before the first session was held and version 3 on the right side was designed after the first session.

Her journal vocabulary also showed her enthusiasm and excitement with the students' learning and responses to events. In the first session students were given a notebook to sketch their designs in, but Najmeh had forgotten to put the notebook to use in class or ask the students to bring it back next session. After the second session she wrote "to our surprise they all brought their notebooks back and all three had drawn something in them which made me super happy!" (March 1, 2018). In other instances, when she did not find the resources she required, she was not set back and created them herself (Figure 11 and Figure 12). For example, for the third session where she wanted students to design a

background, she developed a SCRATCH game so that she could link the game to ocean pollution, whereas she could have used a pre-existing game and simply had students change the background for it. A screenshot of the developed game can be seen in Figure 11.

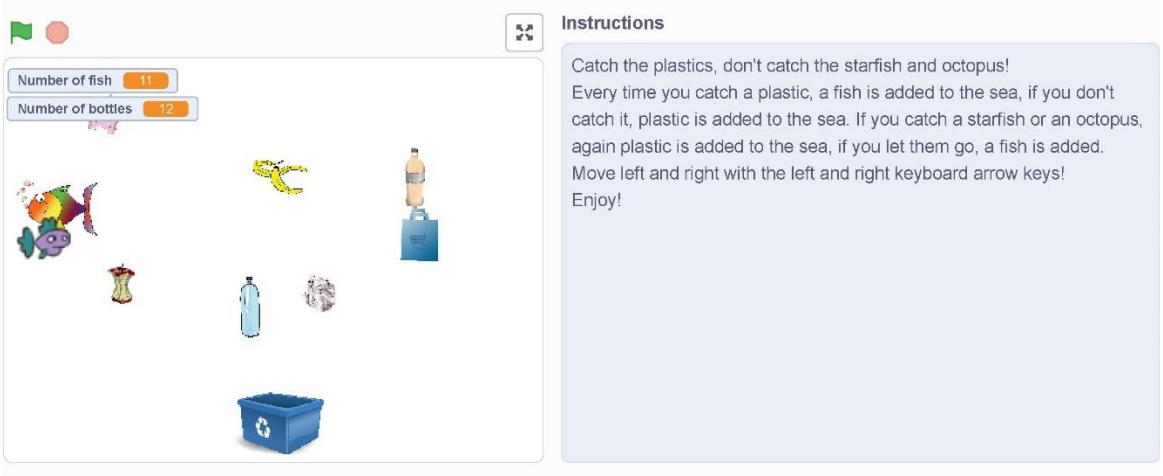

Figure 11. Participant's SCRATCH Game Developed for Third Session

These, along with the innovations she showed were all evidence of proactivity as they were non-mandatory additions by Najmeh. She was an unpaid volunteer at the center who was not required by any means to put this much effort into doing her work. In describing another new teacher at the center, she wrote:

> I once saw another teacher who was going to teach for the first time at the centre. He came in a bit earlier before the class and [the director] told him what to do and he did it! No preparation at all! I can't imagine being him. (February 17, 2018)

Therefore, in this informal setting, she took the initiative to fully design and document her course. She had originally designed her lesson plan "Based exactly on his [the

director's] email" (February 17, 2018). However, like teacher entrepreneurs, she made use of innovative teaching methods and activities such as the use of imagination and meaningful content to better make sense of graphic designing and coding projects in the classroom. For example, one part of session one in her finalized lesson plan (Appendix J) reads:

> Close eyes… Imagine it's raining, but it's not drops of water, each drop is something different, what drops from your cloud? From mine, a watermelon! what about you? Ask everyone. So who lives in a world like this? The people who live here have no umbrellas! One of the people who lives here wants to make one, what kind of a character would be the first person to make this umbrella? … We're going to make that person/creature. (March 28, 2018)

In another example where students were to take their own pictures in front of a green screen and import them in a game, she asked students to act out how they felt in snowy weather so people who had never seen snow before could get a sense of what it felt like (March 17, 2018). In this way, she connected lessons with a story and particular experience for the students (Figure 12). As mentioned previously, she was interested in linking the course to bigger social issues through empathy, however, she feared that doing an empathy exercise in class may upset the students as she wrote "They [students] are basically there to have plenty of fun and inserting empathy is really not easy (March 9, 2018). Through this idea of identifying with someone who has not seen snow before, she was also able to innovatively overcome this limitation by using positive empathy (March 9, 2018). A screenshot of this activity can be seen in Figure 12 where students were to replace the characters with their own pictures.

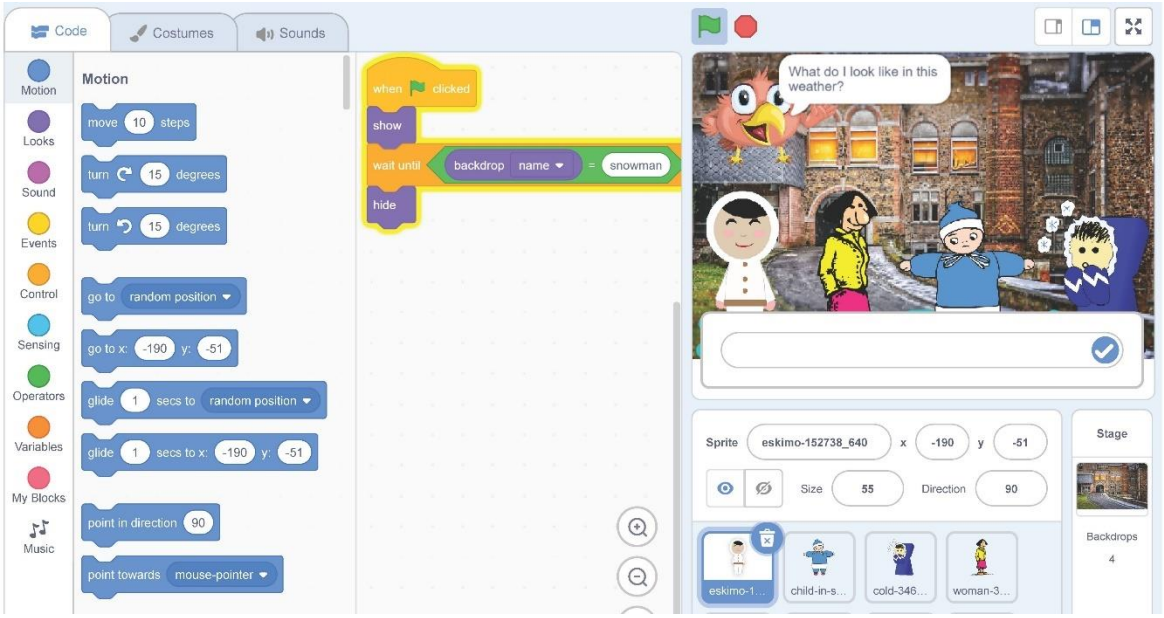

Figure 12. Game Created by Participant Which Employs Positive Empathy. Background changes to snowier weather after each answer.

Even though we see steady innovative input from the teacher, these innovations remain relatively small. But they do coincide with times where Najmeh saw a need for bringing herself more into her own work, meaning the crossroads or becoming the author of one's life stages. Therefore, small innovations were a safe way to test the potential of an environment for change, while staying within norms and avoiding causing conflict.

4.3.1.3 Collaborative

Najmeh showed the value she placed in collaboration for her students by explicitly pointing to the need for it at the center. In one journal entry she mentioned "I rarely see students collaborate in courses here and am eager to add a collaborative activity" (February 27, 2018). In one instance, she added collaboration through an activity (Figure 13) where students place a graphic design order for another student and fulfil an order for

someone else in return (February 28, 2018). After attending a STEM conference, she also thought about the possibility of connecting students with a game development company in a nearby city (March 4, 2018).

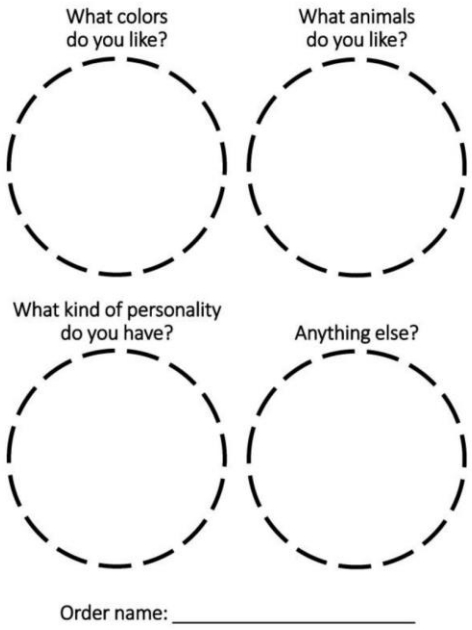

Figure 13. Participant's Collaborative Graphic Design Order Activity.

However, as her professional identity had not developed in the interpersonal dimension enough to focus on mutuality in relationships (Kim & Keyhani, 2019), collaboration for herself was limited and often consisted of one-way interactions where she was either giving or receiving information. She also consciously did not take advantage of many potential collaboration opportunities available to her. For example, a parent showed interest in coming into the classroom which made Najmeh very nervous (March 25, 2018). And we learned that Najmeh had help from a Volunteer during classes whom she rarely mentioned or included in any of her plans or journal entries. At one point, Najmeh

even mentioned that she was a better teacher when no one else was around (March 9, 2018), showing, her preference for working alone.

4.3.1.4 Opportunity-minded

One major change which Najmeh brought to the course was making all the activities in the sessions meaningful for the students. She saw each lesson as an opportunity to do more than teaching graphic design. She either raised awareness for a pressing issue like contaminated oceans (March 9, 2018) or had students enhance their creativity through the use of guided imagination (February 21, 2018). She also continuously looked for ways to expand her teaching content even when attending a conference (March 4, 2018), and if activities were to finish early, she made sure to have a section in each lesson plan which included other things to do if extra time was available. Examples from the lesson plans referring to a number of these instances can be seen in Figure 14.

Session 1 lesson plan V2	Or instead of the code above, open the crate tray game, insert their character as a sprite, and copy the platform codes into their character's script section by dragging and dropping. Then delete the platform sprite. Now play! This way, they can see their character in action and get a better sense of how pieces of a game fit together.
Session 2 lesson plan V3	Now if there is time, go to Gravit and make this backdrop so they see what background design can look like in Gravit which is mostly used to create objects and nobody expects to do other things with it.
Session 3 lesson plan V4	If they have extra time, they can create one or two other modifications of the backdrop, a healthier one for when the player has won, and an unhealthier looking backdrop for when the player has lost and everywhere is full of plastic.
Session 4 lesson plan V5	If time left, they can bring in new backgrounds as well to try more advanced code modifications by linking codes to new backgrounds.

Figure 14. Excerpts From Lesson Plans Regarding the Use of Extra Time.

Although Najmeh showed opportunity-mindedness in a number of cases, the opportunities she pursued were not linked to any particular issue, dysfunction, or crises as mentioned by some studies on teacher entrepreneurship.

4.3.1.5 Present in work

Reflection and analysis of past and current events and adaptability are by far the most prevalent entrepreneurial competency we saw in Najmeh. As can be seen in Figure 9, she adapted to the changing situations she saw herself in by constantly modifying her lesson plan. Her journal entries also showed how she regularly reflected on a variety of details such as personalities, emotions, expectations, designs, and even other possible scenarios of past events. In the following journal entry she reflected on her own decision of the foci of each lesson in her classroom and how her decision affected student learning:

> I want to teach alignment, so I say, if you want the neck and the body [of the character in a design] to be aligned, do this. But I don't want to limit them and say that the neck and body must be aligned, because they don't have to be. (February 21, 2018)

Even though her first imagination activity was a great success recognized by herself, the director, the volunteer, and the students, Najmeh still went back to think about situations where the activity may not have been successful:

> I'm also wondering, how would this have all played out with different types of students? What if we had autistic students like other classes? Some I know would have loved imagination, and some may have found it too slow for them? Would

> this lesson have worked if we had other students who were less cooperative? (February 21, 2018)

In relation to being present in her work, cases of improvisation and use of gut instincts were however, quite limited at this time due to Najmeh's lack of relevant teaching experience and knowledge which was very much in line with her undeveloped professional identity and lack of confidence as a teacher.

4.3.1.6 Knowledgeable

One of the important reasons Najmeh was considered a potential novice teacher entrepreneur in this study was her previous experience with entrepreneurship. Therefore, her entrepreneurial knowledge was pre-known to us, however, we still saw one instance of a direct reference to entrepreneurship in her journal:

> So I thought perhaps in the future this class could be mixed with social entrepreneurship, by having students design orders placed by other students, parents, center attendees or members, or even [the game development company] graphic design team members. Then the company would buy the designs from us to get ideas into the minds of students, or perhaps even use them in real games!! The payment would not be much, but enough to buy reusable bags in a session that they design something related to [the] earth for example. (March 4, 2018)

Her content knowledge was also previously established which was why the director had asked her to teach in the first place Her studies in education had also

provided her with a basic level of pedagogical knowledge which she showcased in a few instances. For example, a journal entry reads:

> He [a student] just wasn't as comfortable expressing himself kinesthetically. And this completely makes sense [that] not all students are going to be comfortable doing the same thing. Their intelligences and characteristics could be different, remember multiple intelligences theory? So there should always be options for them to do something else or do them in another way. (March 25, 2018)

Teacher entrepreneurs are also said to hold knowledge specific to their students, students' families, communities, and the environment which they teach in. In this case, Najmeh had volunteered at the center for nearly seven months prior to this course and had gained knowledge about the STEM community and environment through this previous experience, along with a STEM conference she mentioned to attend while teaching (March 4, 2018). Regarding her students, she often took note of their personalities and designing styles when something stood out for her (e.g. March 1, 2018) which she would use later to address students' needs more properly.

4.3.1.7 Resourceful, risk-tolerant, visionary, and self-Improvement oriented

Resourcefulness, risk-tolerance, vision, and self-improvement orientation were much less visible in Najmeh's work compared to other competencies and they also lacked variation. For example, in relation to resources (apart from the main software used) for activities, we did not see her take advantage of other available resources. One main coding software

she used in all sessions was SCRATCH which is a free software, with unlimited open-source projects available which she could have easily modified for other purposes. However, Najmeh always ended up spending excessive time, creating her own projects. As mentioned earlier, she also had access to valuable human resources such as enthusiastic parents or a volunteer whom she did not want to include in her teaching at that point.

Her risk-tolerance also showed to be relatively low as she checked almost everything with the director (even though it was not required of her). Najmeh was heavily reliant on everyone's approval, and showed the least progress in the interpersonal dimension of her identity development throughout this period (Kim & Keyhani, 2019). The small risks that she took were based on previously gained approvals. For example, her journal entry showed that the reason Najmeh did her first imagination activity without checking it with the director was that a previous idea of hers had received approval. Najmeh wrote "… Then, although I had not initially planned this out from last week, since [the director] gave me good feedback on the lesson plan regarding the order giving section, I took the liberty of incorporating imagination a bit" (February 21, 2018). She also spent many hours at home practicing the software (Gravit, Gimp, Krita, MyPaint, Piskelapp, Magicavoxel, and SCRATCH) and hardware (graphic tablet) she was going to use in her class, to make sure she had everything under control and knew more than the students. Examples of the designs she created at home to practice can be seen in Figure 15.

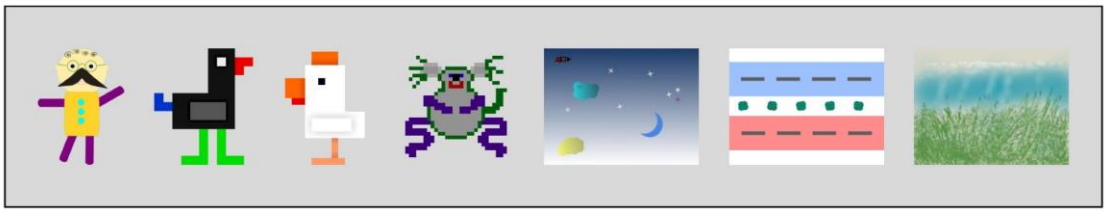

Figure 15. Examples of Participants Own Designs Created for Practicing Purposes. Not all were included in participant's finalized lesson plan.

No clear signs of vision and self-improvement motivation were seen in her work from her teaching. For example, in one or two instances she thought about the future of the course, but those thoughts were on-the-spot ideas which did not have the consistency and strength of a vision that would guide her work. Regarding self-improvement, the new software and skills mentioned above which she learned by practicing at home could be somewhat associated with her improvement. However, her main objective was to reduce her anxiety in class by being able to display herself as a knowledgeable authority which does not quite qualify as an inner drive for the self-improvement orientation competency.

4.3.2 Effects of the Non-Profit Informal STEM Environment

Obviously, many of the challenges faced by Najmeh were because of her lack of experience and newly developing professional identity. However, there were also issues shaping her work and entrepreneurial mindset which resulted from the non-profit informal STEM environment which we will describe below.

4.3.2.1 Length of Program

The course taken on by Najmeh was a four-session course, held over a period of five weeks (once a week with no class in the fourth week). The director of the center had previously indicated that a four-session course yielded the best results in terms of number of student registrations, price of course, and attendance (March 4, 2018). However, regarding developing and exhibiting entrepreneurial competencies, this short time frame was a hindrance for Najmeh. She believed a longer course would have made it much easier to link the contents to broader social issues and the community (March 4, 2018).

A teacher entrepreneur's social motivation and social change related actions inside the classroom are deeply dependent on the knowledge they have about the students and their families or communities (Berry, 2013b). We found that once Najmeh became familiar with the students, she was able to provide more differentiated instruction for them. Even though the laid-back environment of an informal setting was an opportunity for the teacher to potentially have deeper interactions with the students, this relationship did not last long enough for her to really learn enough about the students and build on their individual needs. If the same students showed up to different programs at the center which Najmeh also volunteered for, this issue may have been better. However, this is not something which can be relied upon as students may not attend other center programs and volunteer teachers may not teach other programs at the center either. If the center were not a non-profit, it is possible that some of this information would have been clearer because teachers may have been formally employed for particular time periods.

4.3.2.2 Stakeholder Expectations

When Najmeh was considering linking the course content to real-world social issues, she sensed she was held back by the expectations she felt the stakeholders had. For example, at one point she thought about using empathy to create awareness about a social issue which they could potentially work on in the classroom. However, she quickly changed her mind as she wrote:

> If they [students] don't have fun they won't ask their parents to bring them back and their parents don't want them to get sad in a class they pay for either. It would also be bad for business. In STEM courses, expectations of excitement and fun are way too high. (March 9, 2018)

Hence, to Najmeh, expectations of a program consisting of non-stop fun and excitement felt like a barrier to connecting the course to the social issues she had in mind.

Alongside high expectations of fun, there were also low expectations of content learning and accountability. In the case of Najmeh, the lack of formal assessment expectations in the non-profit informal setting could have contributed to the misguided dedication she displayed when she put much time and effort into her work to achieve stakeholder satisfaction as opposed to student advancement. perhaps

4.4 Discussion

Similar to the interdependencies of the epistemological, intrapersonal, and interpersonal dimensions of the self-authorship framework which Najmeh displayed (Kim & Keyhani,

2019), our findings in this case study also reveal an interdependency of the teacher entrepreneurial competencies.

4.4.1 The Competencies

The nascent teacher entrepreneur of our study, who is also a novice teacher with a newly developing professional identity, displayed several entrepreneurial competencies seen in experienced teacher entrepreneurs, but with different qualities, variations, and intentions behind them. She was (socially) motivated by her students' and the society's needs and worked very hard (dedicated) for preparing and delivering the course, often energetically going overboard (proactive) with doing more than was asked of her. However, her identity being in the Following Formulas stage (Kim & Keyhani, 2019), a lack of time to properly assess students' needs, and stakeholder expectations hindered her attendance to classroom and outside-of-the-classroom-level issues. Her dedication stemmed from her need for stakeholder satisfaction, and her innovations and chosen opportunities were mostly minor, repetitive, and convenience-based, whereas more experienced entrepreneurs have been said to act more diverse and turn problems and dysfunctions into opportunities (Borasi & Finnigan, 2010).

Her one-way collaboration and approval-seeking relationship with the director is highly in line with the wealth of literature pointing to the importance of mentors for both novice teachers (Clark, 2012; McCann & Johannessen, 2010; Sterling & Frazier, 2011) and nascent entrepreneurs (St-Jean et al., 2018), especially when the mentee sees a certain level of similarity between themselves and the mentor (St-Jean, 2012). The director who also taught classes at the center was at times like a mentor for Najmeh who she checked

her work with and used the emotional support she received from his approvals to take further progressive steps in her work. This is also in line with interdependencies of the self-authorship framework where Najmeh's interpersonal dimension (relationships) affected her intrapersonal (her understanding of herself as a teacher) and epistemological (her knowledge) dimensions.

Her continuous reflection and adaptability (presence in her work) were seen as a powerful force behind her decisions and the enhancement of other entrepreneurial competencies such as being knowledgeable and opportunity minded. It can be argued that Najmeh showed much reflection only because it was asked of her to write a journal, and journal writing is itself closely connected to reflection (Spalding & Wilson, 2002). However, we had not given any details to the teacher as to what she should write in the journal. Najmeh could have taken on more of a descriptive approach in her writings, but she showed much willful self-reflection which displayed her understanding of the importance of reflection and reflexivity in her work. Although literature on the importance of reflection for novice teachers (Naci Kayaoğlu et al., 2016; Trent & Gurvitch, 2015) is abundant, the novice entrepreneurship literature does call for more research to be carried out on reflection in entrepreneurship education (Ingrid Le & Barnard, 2013; Kassean et al., 2015). Najmeh's presence in her work here is also closely linked to the intrapersonal dimension of the self-authorship framework which can help enhance the other dimensions as well.

The reasons behind Najmeh's weak display of entrepreneurial resourcefulness become clear when compared to the very nature of true and experienced entrepreneurs. Schumpeter (1983), one of the major theoreticians of the field, introduced the

entrepreneur as one who creates “new combinations” (p.66) which result in value creation. These combinations can refer to the reconfiguration of any of the tangible or intangible resources related to the entrepreneur’s work. The elegancy and intricacy of this act is one of the major defining elements of entrepreneurship which clearly mean it is not easily attainable by aspiring or novice entrepreneurs. Teacher entrepreneurs are said to acquire and handle resources in a unique value-creating manner (Maranto, 2015) and this entrepreneurial resourcefulness requires much knowledge on existing and possible curriculum elements and their combination values (Dillon, 2009).

Vision, self-improvement orientation, and risk-taking were understandably limited as they are strongly linked to experience and progress in the self-authorship framework. Many teacher entrepreneurs are said to have strong visions which act like doctrines for them (Omer Attali & Yemini, 2017). However, the case of Najmeh shows that if this vision does not already exist to steer the entrepreneur from the start, creating it will be a long-term process because it is in the Becoming the Author of One’s Life stage where the teacher starts to determine who they are or want to be as a teacher and what they value the most. The self-improvement orientation competency also requires a good level of self-recognition which can point the teacher to the areas they want or need to improve in. Reliable relationships and supportive environments are said to strongly encourage teacher entrepreneurial risk-taking (Hanson, 2017) which were present in Najmeh’s case, however, we saw that without a certain level of self-confidence and identity development, aspiring teacher entrepreneurs may not be able to take bigger risks.

4.4.2 The Non-Profit Informal STEM Environment

The short length of her course at the center was mentioned to be a barrier for socially motivated actions, both at the classroom level and especially beyond. This is in line with literature which have in general shown more positive results for long-term informal STEM programs (Alliance, 2011; Nite et al., 2017) and pointed out the difficulties of going deep into STEM concepts during short-term programs (Dani et al., 2018). In the case of Najmeh, linking the course to broader social impact could have possibly been facilitated by considering what can be done with iterations of the course, as opposed to just the one time the course was held, with one group of students. Or perhaps another solution would have been for her to think of what the course could do in conjunction with other courses taught at the center.

Specific knowledge on informal STEM education could have also helped the teacher come up with practical social value ideas to pursue in shorter durations of time. For example, the lack of women and minorities in informal STEM environments (Vallett et al., 2018) and the reported low sense of social responsibility in STEM students (Garibay, 2015) could mean simple appraisals of certain groups or designed critical thinking activities which can all happen in one session, may easily become part of a bigger social impact a teacher entrepreneur can pursue. Competencies which go hand in hand with these ideas are a strong vision for the course and a broader outlook of possible opportunities.

The stakeholders' high expectations of fun, and low expectations of content learning were also significant in this study. While looking into Najmeh's dedication, we saw her

efforts were mostly aimed at receiving stakeholder satisfaction. As mentioned by Keddie (2017), accountability to external stakeholders made some teacher entrepreneurs' dedicated to making the learning in their classrooms more visible. Therefore, even though accountability measures may arguably become restrictive for some teacher entrepreneurs, they may also be helpful in guiding the efforts of some new teacher entrepreneurs at the beginning of their identity development journeys, to focus on students' improvement (as opposed to their own reputation for example). This is very much in line with current efforts to improve evaluation in informal STEM environments (Bequette et al., 2019).

However, it is also important for teachers to understand the actual goals of informal education. Allen and Peterman (2019) show how informal STEM learning outcomes now clearly go beyond simple content learning and include interest, identity building, and engagement. These learning outcomes closely relate to stakeholder expectations of fun and the low content learning expectations seen in the non-profit STEM center of our study. Once again, a teacher entrepreneur's knowledge about various informal STEM learning objectives and the center's goals and mission can help the entrepreneur design and align their own ideas and expectations better with the stakeholder's ideas. Then, possibly, stakeholder expectations can be embraced and looked at in the form of opportunities.

4.4.3 The Teacher Entrepreneur vs. the Good Teacher

One of the most common questions which is raised when we speak of teacher entrepreneurial competencies is that, are teacher entrepreneurs simply the same as good teachers? To answer this question, we must differentiate between one having

entrepreneurial competencies, and one actually being an entrepreneur. A teacher who simply exhibits a number of entrepreneurial competencies, such as the participant of our study, can be said to have entrepreneurial competencies (to any extent) and may have the *potential* to be an entrepreneur. However, to clearly label someone as an entrepreneur, the competencies they display must relate to one another, build on one another, and move in the direction of the end goal which motivates the teacher. For example, a teacher cannot pursue opportunities in one area, innovate in a different area and for another purpose, and still be considered an entrepreneur. As social entrepreneurship was defined at the beginning of this chapter, it involves "the innovative use and combination of resources to pursue opportunities to catalyze social change and/or address social needs" (Mair & Martı´, 2005, p. 3). A clear entrepreneurial journey exists which is shaped by the entrepreneur's vision and objective. Although serial entrepreneurs (those who go through this process in various areas sequentially) and portfolio entrepreneurs (those who go through this process in various areas concurrently) also exist (Ucbasaran et al., 2008), each strand of their entrepreneurship has its own reasonable integrity. Therefore, teacher entrepreneurs may be categorized as *good teachers*, but they are a certain type of good teacher who goes through the entrepreneurial process. In this study, we have merely focused on entrepreneurial competencies which teacher entrepreneurs have been mentioned to have.

4.5 Implications and Future Research

Our study points to the importance of mentorship (in line with the interpersonal dimension), reflection (linked to the intrapersonal dimension), and context specific

knowledge (connected to the epistemological dimension) for novice teacher entrepreneurs' growth and development. Therefore, providing any of the above can remove barriers and help facilitate a novice teacher entrepreneur's journey. Our study also showed that aspiring teacher entrepreneurs may find it easier to practice some competencies (or sub-categories of competencies) sooner than others. For example, seeking relevant knowledge, being on the lookout for opportunities, and implementing small innovations, as opposed to deciding on a big vision (if vision did not pre-exist) and trying to move towards it, or taking risks where previous experience, confidence, and well-established relationships do not exist enough to help support Najmeh by making those risks more calculated. In line with the importance of reflection, we also suggest novice teacher entrepreneurs take on more holistic and ecological views of their environments and imagine what the entrepreneurial elements they know of could mean for each part of their setting. For example, as mentioned above, what can an opportunity mean when thinking of expectations, course content, or social impact? The same difference in meaning could be reflected on for all entrepreneurial competencies. Overall, this study contributes to a larger body of literature on teacher entrepreneurship and what it consists of in theory and practice by showing how a novice teacher entrepreneur exhibits entrepreneurial competencies and how the environment they are in, affects their competencies. Because Najmeh is also a novice teacher in this case, the study also contributes to work on novice teachers' behavior and progress. Finally, this study adds to literature on informal STEM environments by presenting some of the challenges and possible opportunities they have for teacher entrepreneurs.

We suggest three main pathways for future research in this area. First, more research needs to be done on defining novice teacher entrepreneurs. Because of Najmeh's background, we were able to label them as a potential novice teacher entrepreneur. However, as each person's experiences are different, it is not clear who can be considered a novice teacher entrepreneur, and whether that person will also always be a novice teacher or not. If the two concepts do not overlap, what will be the differences between an experienced teacher who is a novice entrepreneur and a novice teacher who is also a novice entrepreneur? Second, research should investigate how a new teacher entrepreneur displays their competencies in a formal setting and what challenges they face in that environment. The demands of informal settings without standardized curricula and assessments vary hugely compared to formal settings (National Research Council, 2009) and much insight can be provided by comparing these two environments together. Also, educators in formal settings are usually required to have undergone formal teacher education which can also have an impact on how entrepreneurial competencies are displayed. Third, higher numbers of novice teacher entrepreneurs in any setting need to be studied to look for possible patterns in their behavior. If a pattern is found or the lack of a pattern is displayed, supporting teacher entrepreneurs would need to be designed accordingly. This study was an in-depth analysis of only one teacher entrepreneur. Much depended on our participant's prior knowledge, experiences, and relationships, whereas actions and competencies may have been quite different for another individual.

4.6 Conclusion

Teacher entrepreneurship is a new and evolving concept in its early stages of development which calls for research into the works of teacher entrepreneurs and the environments they work in to be able to better understand and support them. Over a period of six weeks, this qualitative study followed Najmeh's journey in designing and carrying out their first STEM course in a non-profit informal STEM center. We investigated how a potential novice teacher entrepreneur exhibited entrepreneurial competencies and what some of the intricacies and interdependencies of the entrepreneurial competencies were. Some competencies displayed by Najmeh differed in quality (e.g. opportunity-mindedness) or by the intentions behind them (e.g. dedication) compared to relevant literature, and a number of other competencies were overall less visible or non-existent in her work (e.g. vision, risk-tolerance, and self-improvement orientation). Length of program and stakeholder expectations were discussed as challenges brought about because of the nature of the non-profit informal STEM education environment and possible solutions for the challenges were presented.

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Chapter 5

5 Multiliteracies teachers as teacher entrepreneurs: A conceptual comparison

In response to the need for an adapted literacy which can help people make meaning in their lives, the pedagogy of multiliteracies was proposed by the New London Group in 1996 to ensure various diversities are recognized and valued properly. The concept of design is a crucial one in the meaning making process of multiliteracies where Available Designs are turned into the Redesigned through a Designing process. Available Designs are the resources which we use (such as the grammars and conventions associated with semiotic systems and activities), Designing is when we transform the Available Designs (such as when we are observing or hearing), and as a result, the Redesigned is created which is a new meaning; one different from the original Available Designs.

Meanings can have various modes such as linguistic, gestural, audio, spatial, tactile, and visual and the usual combination and connection between these modes, is referred to as multimodal (Cope & Kalantzis, 2015). According to Kalantzis and Cope (2010), the knowledge processes students go through to build knowledge consist of immersion in communities of practice (situated practice or experiencing), intentional interventions by teachers meant to guide the learner in the recommended path (overt instruction/conceptualizing), framing of learners' knowledge in bigger structures (critical framing/analyzing), and carrying out practice again, but this time with their new understanding and based on their own objectives (transformed practice/applying).

The intricacies of the pedagogy are vast and endless possibilities face a multiliteracies teacher on a daily basis which are far different from what a teacher faced traditionally. As a result, multiliteracies teachers require much support for carrying out the pedagogy. We intend to conceptualize the multiliteracies teacher as a *teacher entrepreneur*, who can be categorized as a type of *social* entrepreneur. We then offer new insight on ways to support multiliteracies teachers through an entrepreneurial perspective. For the purpose of this comparison, we consider the multiliteracies teacher to be an ideal one, meaning one who knows the multiliteracies theory very well and does their work intentionally and with proper reasons behind their choices, and the same holds true for teacher entrepreneurs.

5.1 A Critical Review of Multiliteracies and Teacher Entrepreneurship

Based on a literature review on multiliteracies pedagogy and teacher entrepreneurship, this paper intends to address the research questions including (a) how can we use teacher entrepreneurship concepts to support multiliteracies teachers better?; (b) how are multiliteracies teachers and teacher entrepreneurs conceptually alike?; and (c) what are some examples from a multiliteracies classroom which show these similarities?

Drucker (1985) defined the entrepreneur as one who “always searches for change, responds to it and exploits it as an opportunity” (p. 33) and does not necessarily need to have a financial profit motive. Schumpeter (1983) who is also one of the major theoreticians of the field, introduced entrepreneurs as those who come up with reconfigurations or “new combinations” (p. 66) that lead to value creation. One type of

entrepreneur is the social entrepreneur, who has “a mission to create and sustain social value” (Dees, 1998) and carries out an “innovative, social value creating activity that can occur within or across the non-profit, business, or government sectors” (Austin et al., 2003, p.2). Based on a systematic literature review of teacher entrepreneurs carried out by Keyhani and Kim (2020), teacher entrepreneurs can be considered a type of social entrepreneur who are *socially motivated* and *opportunity-minded* individuals and *risk-takers* who are also *knowledgeable, visionary, innovative, collaborative, present in their work, resourceful, proactive, dedicated,* and *self-improvement oriented*. Using the mentioned traits and competencies, this conceptual paper compares teacher entrepreneurs with multiliteracies teachers, provides examples from a multiliteracies classroom, and offers possible new ways to support multiliteracies teachers. The teacher, Rosanne (pseudonym), whom we talk about in this article is a self-reported multiliteracies kindergarten teacher in Canada, formally versed in the pedagogy of multiliteracies (through her master’s in Education). To provide practical insight, we provided examples from her interview transcripts, classroom observation notes and pictures, and the teacher’s classroom assessment documents. This data was originally gathered for another study from the beginning of January 2019 until the end of June 2019.

5.1.1 Socially Motivated

The starting point of teacher entrepreneurship is an existing problem in the classroom, educational system, or society which altruistic and passionate teacher entrepreneurs (Hess & Finn, 2007; Maranto, 2015) are motivated to solve at two levels. First, at the student level which is often a lower or classroom level at which they seek to address students’

needs in ways such as using differentiated instruction (Dennis & Parker, 2010). Second, at a higher societal level, they seek to create social change, for example by attempting to raise awareness about students' needs (Berry, 2013).

Multiliteracies teachers are also socially motivated on both levels. As Cope and Kalantzis (2000) explain, through a multiliteracies pedagogy the teacher's objective is to help promote *Productive Diversity* in the workplace where differences are invested on and the organization is as diverse as the markets it strives in. The teacher also intends to take steps towards achieving a *Civic Pluralism* in the society where unequal lifeworlds are acknowledged and supported by various types of self-government and a neutral but arbitrator top level government. And in personal lives, the multiliteracies teacher leaves no one behind by bringing to the front, the multiple layers of each identity. Overall, this objective society is referred to as the *Knowledge Society* (Kalantzis & Cope, 2016c). At the classroom level, the multiliteracies teacher addresses students' needs through a pluralist education where equity is possible because students hold on to their true different selves and still have similar employment, political, and community related opportunities. The multiliteracies teacher offers this type of differentiated education by understanding the possibilities offered by various modes of meaning and putting them to use in conjunction with the students' needs and preferences and by stressing the notion of meaning making as a designing process which extends to students eventually designing their social futures (Kalantzis & Cope, 2010; The New London Group, 1996).
Rosanne, our multiliteracies teacher was very dedicated to providing students with various opportunities to connect with different modes of meaning in several contexts. Each week she set up different learning stations for students to work at and offered them

the choice to choose whichever station they wanted. For example, one station had various concrete objects such as dinosaur figures for students to work with, while another desk had papers and video tutorials on how to create origami shapes. Each activity center utilized various levels of knowledge building processes. For example, the dinosaur figures station had books on dinosaurs for students to conceptualize their knowledge while the origami station, in addition to video tutorials (conceptualizing), had an expert student who helped others out (experiencing).

5.1.2 Knowledgeable and Self-Improvement Oriented

Teacher entrepreneurs are said to have good knowledge of the contents they teach (Bell, 2016) along with knowledge on pedagogy and their students, communities, and families (Berry, 2013). They use their information on their individual students in conjunction with their teaching and philosophical beliefs to create unique value (Hunzicker, 2017). They enthusiastically look for professional development (Amorim Neto et al., 2019) and personal achievement opportunities by taking on work that is both interesting and challenging (van der Heijden et al., 2015).

The differences of the lifeworlds of students are what shape the pluralist education mentioned before. A multiliteracies teacher has knowledge of the lifeworlds of their students in order to match them up with the appropriate knowledge building processes, available designs, and forms of meaning. Students' lifeworlds consist of their public, personal, and future working lives (The New London Group, 1996), therefore, learning about the families and communities which students are connected to is crucial. Multiliteracies teachers must also be knowledgeable about what the pedagogy consists of

such as the designing process, the various forms of meaning, and the knowledge processes to know what pedagogical elements exist that they can use. As Cope and Kalantzis (2015) mention, "*Learning by Design*" (p. 31) also refers to what the teacher does as well as the student. The teacher chooses from a variety of activities, decides on their orders, and contemplates what learning will result from them. This pedagogy per se is a constant learning process for teachers (Kalantzis & Cope, 2016b, p. xi).

The kindergarten teacher of our study showed signs of a continuous interest in improvement. Although she was already an qualified Early Childhood Education (ECE) teacher, she felt the need to further her education and studied a master's in education. During classroom activities, if Rosanne's students were not engaged, she would take into account the reasons for this and redesign future activities which showed her own *learning by design* process. She also used the *Seesaw*[2] application frequently to gain more knowledge of the lifeworlds of students. In her first interview she said,

> …parents have said, oh, I'm not surprised so and so was doing this. We just went wherever and had friends do whatever. And so I didn't know about that home experience, but that helps me understand where this certain behaviour was coming from and so that I can support it in the classroom (July 6, 2019).

5.1.3 Visionary and Present in Work

Teacher entrepreneurs have broad and strategic visions along with a clear presence in their work. They are idealists (Maranto, 2015) with strong imaginations (Nash, 2014) as

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[2] An online platform for storing and sharing digital student portfolios and communicating with parents.

they are able to visualize their objectives and move in that direction by keeping in mind both inside and outside of their classrooms (Amorim Neto et al., 2019). They regularly rely on their "gut instincts" (Borasi & Finnigan, 2010, p. 18) and insert their opinions into their work through self-efficacy and self-trust (Dennis & Parker, 2010). They reflect and modify curricula to make sure it meets their students' needs (Oplatka, 2014) and they use data which is available to them to make better decisions (Dennis & Parker, 2010). Multiliteracies teachers also have a strong imagination as they must envision the reflexive knowledge society (Kalantzis & Cope, 2016c) they are striving to move towards. They must be able to see broad enough to choose when to use which knowledge process and how. As Kalantzis and Cope (2016b) put it, the learning by design process is the "process of imagining how learning might be different and more effective" (p. x). This new type of learning should also "allow for alternative pathways and destination points in learning" (p. 26). However, it is the multiliteracies teacher's willful indulgence in the imaginations and constant reflection on them which gives them existence. The teacher designer is a crucial part of the multiliteracies pedagogy and the learning by design process because the transformative curricula they use is heavily dependent on them (Kalantzis & Cope, 2016a).

Weather permitting, Rosanne held many of her classes outside. In one of our conversations, she mentioned she believes that teachers tend to let students play with less rules and risk more in an outside environment as opposed to inside (April 18, 2019). Her reasoning behind this decision shows her strong vision of where and how more and different possibilities can be created. Even though she may be the one who is implementing the rules she refers to in the classroom, her awareness of this issue points

to her broad and strategic vision. It also points to the fact that she reflected on this issue by analyzing the differences in students and staff members like herself when students were outside compared to inside.

5.1.4 Innovative and Opportunity-Driven

Entrepreneurial teachers see problems as opportunities for the social change they have envisioned (van der Heijden et al., 2015). On their journey to social change, they exhibit innovations. Joseph Schumpeter (1983), known as the father of entrepreneurship, introduced entrepreneurs as those who come up with reconfigurations or "new combinations" (p. 66) that lead to value creation. For teacher entrepreneurs, innovation has been implementing new teaching methods such as experiential learning (Dennis & Parker, 2010).

In the pedagogy of multiliteracies, the focus which exists on the concept of design gives teachers a "creative intelligence" (p. 19) which enables them to continuously regenerate activities as needed by using Available Designs, Designing, and creating the Redesigned which is always and inherently new (The New London Group, 1996). The multiliteracies teacher employs experiential learning and uses meaningful content specifically through the use of situated and transformed practice (Cope & Kalantzis, 2015). In a learning by design setting, all learners are not required to be "on the same page at the same time" (Kalantzis & Cope, 2010, p. 216). A multiliteracies teacher must be innovative to be able to respond to each student's unique situation. For a multiliteracies teacher, none of the knowledge processes have priority over the other (Kalantzis & Cope, 2010). It is the *new combination* of these pedagogical elements which the multiliteracies teacher creates

distinctive value from, based on differences between and amongst learners and their cultures, along with the nature of the disciplines taught and pedagogies used (Kalantzis & Cope, 2016d). The multiliteracies teacher is therefore, a *new teacher* who teaches *new learners* (Kalantzis & Cope, 2010).

In Rosanne's classroom, on a regular basis, students brought in items which were interesting to them and the teacher would instantly create new ways of incorporating those items. For example, one day a student brought in a bulrush plant to show everyone. The teacher took some of the top fuzzy section and put it in a separate bag and asked the student if they thought what was in the bag was the same as what was on the bulrush. Together, they created an activity for other students to try and figure out whether those two items were the same or not. As Rosanne put it "we are ongoing and we're always in the moment with them" (July 6, 2019).

5.1.5 Collaborative

Teacher entrepreneurs have been mentioned to collaborate with one another for knowledge sharing purposes (van Dam et al., 2010), making innovations more practical, and creating exclusive educational experiences (Oplatka, 2014; Schimmel, 2016). By staying in touch with people and communities outside of their classrooms, teacher entrepreneurs can better provide collaboration opportunities for their students (Hess & Finn, 2007) as they strongly believe students should collaborate with one another and the community (Hanson, 2017).

According to Gee (2000), current day networking and networks take place in "distributed systems" which no longer have central brains and are made up of local parts which

flexibly combine with one another to change their environment or adapt to it. Therefore, the individual and their stand-alone knowledge lose their significance and collaborative knowledge building skills gain importance. As a result, multiliteracies teachers believe in nurturing a particular *kind of person* (collaborative), with particular skills; those who are "comfortable with themselves as well as being flexible enough to collaborate and negotiate with others who are different from themselves" (Cope & Kalantzis, 2009, p. 174). Therefore, regarding collaboration for their students, the multiliteracies teacher emphasizes the interpersonal in order to invest in productive diversity, and for themselves, they rely on online documentation for knowledge building and sharing purposes, which makes them competent collaborators (Kalantzis & Cope, 2010). Rosanne invested a lot on student to student collaboration, especially during *experiencing* knowledge processes. She chose activities in which at least one student was proficient and could help others understand better through scaffolding. For example, this was the case for the origami creating and dinosaur stations mentioned before. Regarding the use of Twitter, in her interview she said:

> …students may want to post something or we'll tweet out something together and then get responses from other schools, other teachers, other places too (July 6, 2019).

Regarding her own collaboration, documentation took up a substantial part of her role as she extensively recorded data from class activities and observations and shared them with other teachers. Rosanne used this data to connect with families, and work with and consult other staff members.

5.1.6 Resourceful

Teacher entrepreneurs are not limited by a lack of resources as they secure what they need through various pathways such as crowdfunding (Bulger et al., 2016), establishing strategic partnerships (Martin et al., 2018), and networking (Bills et al., 2015). Teacher entrepreneurs also proficiently manage the resources they currently have at their disposal to make the best use of them (Nash, 2014).

Multiliteracies teachers use a wide range of resources compared to traditional teachers such as new environments, technologies, and games (Kalantzis & Cope, 2016b), along with students' experiences and lifeworlds (Gee, 2000). Also, when speaking of Available Designs as teaching resources, each meaning making process ends in a Redesigned which can be used again as an Available Design (The New London Group, 1996). Therefore, a multiliteracies teacher is faced with unlimited resources and must be able to choose from them properly.

Rosanne set up a Tinker station which was a place where material brought from students' homes were placed for students to build structures with. Through this method, she ensured free and new resources on a continued basis for students to work with while keeping in mind that these resources which came from students' homes, also provided insight into the students' lifeworlds which she used to communicate with students.

5.1.7 Dedicated and Proactive

Teacher entrepreneurs are committed to their students as they feel accountable for their learning and future. They are described as both persistent and proactive (Hanson, 2017) with a strong sense of responsibility to provide high quality education beyond what has

been asked of them (van der Heijden et al., 2015). The teacher entrepreneur's proactiveness can also be seen in their constant innovations, resource acquisition and management, networking, and opportunity seeking.

According to Kalantzis and Cope (2016b) multiliteracies teachers require and use tools which are "the basis for transparency and accountability that moves these new professionals beyond reliance on textbooks and mandated syllabuses" (p. x). They believe such tools provide this basis because they facilitate documentation, curriculum mapping, reflection, and knowledge sharing between educational stakeholders. The use of such tools is often not mandatory and are chosen to be used by teachers themselves which shows their proactivity and internal sense of dedication for transparency and accountability. The very fundamental concepts of teacher as designer, knowledge processes (Kalantzis & Cope, 2010), and the use of multimodalities (The New London Group, 1996) paint a picture of a proactive and persistent teacher, always on the lookout to decide what to design, when, why, and how.

Much of Rosanne's documentation was on the Seesaw application where she was in touch with parents and showed them what happened in her classroom while there was no outside pressure on her to do so. She persistently felt the need to keep parents connected to their children's school lives in order to learn about her students from them. Also, when designing group activities for the whole class, she felt compelled to ensure no student is left out. She put much time and energy into designing the activity in a way that it would combine various modes of meaning in order to reach every single student. For example, Rosanne designed an activity about emotions where she presented a story using pictures on posters. One picture showed a smiling child and the other a frowning one. Then she

picked students to imagine a scenario and act out their feelings. After that, they all sang a song about emotions and used sign language. Later on, she constantly built on this experience when the opportunity arose.

5.1.8 Risk-taker

Taking calculated risks is something else teacher entrepreneurs are known for. Continuous innovations and testing of new technologies and ideas carry with them much uncertainty and risk (Amorim Neto et al., 2019). By moving forward despite the existing uncertainties, they risk losing their reputation, time, money, and other resources (Schimmel, 2016). To minimize these risks, using their experience and knowledge, they reflect on their decisions and constantly re-evaluate the opportunities they pursue (Borasi & Finnigan, 2010).

The unlimited resources multiliteracies teachers have at hand translate into unlimited opportunities with endless pedagogical combination possibilities which mean a high level of uncertainty and risk are involved. For example, according to Cope and Kalantzis (2015), in the *experiencing* knowledge process there is *experiencing the known* and *experiencing the new.* In experiencing the new, students need to be immersed in unfamiliar experiences which are within their safety and intelligibility zones for them to be both meaningful and transformative at the same time. If not, students' learning will be compromised, therefore, the transformative curriculum which teachers use, relies on their own "interpersonal intelligence" (p. 50) for failure or success, and needs the backing of pedagogical rigor even though it must heavily use learners' subjectivities as guidance (Kalantzis & Cope, 2016a). Hence, there are risks of wrong judgements throughout their

work which they try to minimize by learning more about their students lifeworlds, the society, and the multiliteracies pedagogy. Documentation also helps reduce risk as multiliteracies teachers can constantly refer to their learnings and make more calculated risks over time.

Risks are difficult to observe, however, instances exist which point to the fact that the risk of a *failure* was present and did indeed happen. Such as when Rosanne tried using a desktop computer to connect to a microscope which turned out to be cumbersome because a desktop computer proved to be too unfamiliar for students, requiring too much input from her side to make the experience educational. As a result, she decided not to use the desktop computer with the students anymore.

5.2 Discussion

Following the similarities found between the two concepts of teacher entrepreneurship and multiliteracies, we looked into the literature of entrepreneurship to explore possible ways of better supporting multiliteracies teachers. Our learnings can be categorized into three suggestions of a wider use of innovation, practicing paradoxical leadership skills, and creating optimized networks.

5.2.1 Wider Use of Innovation

Innovation is key in the entrepreneurial process and it can manifest itself in various elements of an entrepreneur’s work. The new combinations which Schumpeter (1983) defined for entrepreneurs referred to new products or services, new ways of producing, new markets to enter, new sources of supply, and new organizations of an industry. In the

context of a teacher's work, new combinations can be new topics to be taught (such as STEM, black history, etc.) or new roles a teacher may take on (mentor, consultant, etc.), new ways of teaching (e.g. experiential learning), new students to teach to (e.g. teaching parents alongside their kids or reaching students with special needs not attended to before), new resources to use (such as new technologies), and new ways of organizing the teaching process or any of its elements (such as new ways of collaborating with other teachers or institutions). As explained previously, multiliteracies teachers' innovation is mostly seen to be focused on the unique situations they are faced with on a daily basis and the new ways they combine the pedagogical elements of multiliteracies for each student or situation.

We believe multiliteracies teachers can benefit from innovation and new combinations in other sections of their work as well. For example, multiliteracies teachers struggle with the limitations of their schools' resources, a lack of support from other teachers, and a lack of knowledge on how to put multiliteracies concepts into practice (Boche, 2014). To overcome such challenges, they can proactively seek new ways of accessing professional development, finding support for their work, or acquiring more resources. To do so, multiliteracies teachers must become aware of the innovation that they are already exhibiting in their work and attempt to guide that innovation to other areas of their jobs as well. A wealth of brainstorming and creativity methods have been developed (Dromereschi, 2016) which can be used for professional development purposes of pre and in-service teachers to help them imagine innovation in various elements of their work and to take better control of their creativity.

5.2.2 Practicing Paradoxical Leadership Skills

Social entrepreneurs are well known for the competing and often paradoxical social and economic demands they must address (White et al., 2018). On the one hand, they strive to achieve public and social value, but on the other hand they are simultaneously faced with economic goals in order to achieve sustainability, as pursuing social goals may themselves not be financially fruitful enough. Similarly, multiliteracies teachers often face the opposing challenges of wanting to use a transformative curriculum, but at the same time being required to measure learning and report it back to parents and the administration in standardized ways (Kalantzis & Cope, 2016a; Phillips & Willis, 2014). When misalignment happens in such paradoxical situations, tensions arise (Cooney, 2006) and a variety of negative defensive reactions may occur (e.g. chaos, mistrust, destructive conflict, etc.) depending on the type of paradox at hand (Lewis, 2000). To avoid choosing one side of the conflicting demands, using paradox research, Smith et al. (2012) introduce three skills for social entrepreneurs to embrace their paradoxical demands; *acceptance*, *differentiation,* and *integration*.

According to their study, acceptance consists of taking on the mindset that the two competing goals can be pursued and achieved simultaneously using an abundance mentality (ability to see resources as abundant and renewable with the help of collaboration) and paradoxical thinking (ability to consider both sides of a paradoxical situation simultaneously). Differentiation refers to a careful recognition and analysis of each demand to see the specific contributions it can make. This can be done by recognizing the specific value each side has and thoughtfully attending to these distinctions, followed by an exploration of the innovative instances in each domain. And

finally, integration is the skill of "identifying creative synergies" (p. 472) between the competing domains through strong interpersonal skills (which include openness, reliability, and cultural sensitivity) along with synergy seeking decision making skills. We believe the three skills and their subskills can also be useful for both pre and in-service multiliteracies teachers. In Table 3, we offer examples of the three mentioned skills in relation to multiliteracies teachers.

Table 3: Examples of Ways Pre and In-service Multiliteracies Teachers Can Practice Paradoxical Leadership Skills

Skill	Sub-skill	Pre-service multiliteracies teachers	In-service multiliteracies teachers
Acceptance	Adopting an abundance mentality	Ask students to develop open source lesson plans with one another	Collaborating with other people and organizations to see new possibilities
	Embracing paradoxical thinking	Ask students how a teacher can incorporate technology in their classrooms when they have no computers and no budget for them either?	Playing around with the timing of some activity types to see if they yield better final test results (for example, making sure to do some conceptualizing activities closer to test dates)
Differentiation	Recognizing the distinct value of each domain	Have students map out the goals and benefits of standardized assessments and in another assignment look at videos of best practices of multiliteracies teachers	Reflection on past experiences of both multiliteracies activities and standardized tests, speaking to old-school teachers who enjoy standardized testing to get their perspectives, or training on topics (e.g. statistics) which can shed light on the benefits of standardized tests
	Mindfully	Consider a standard	Apart from results of

	attending to distinctions between domains	classroom setting and start questioning the obvious. For example, why do we have chairs in the classroom?	standardized tests, creating reports and non-standardized assessments based on the social impacts which the teacher feels students' work have had and presenting them to parents and other stakeholders separately but side by side for discussion
Integration	Developing trust, openness and cultural sensitivity	Sharing possible scenarios of sensitive situations and going over possible ways to react to them with teacher candidates	Being open to hearing opinions and feedback from any of the stakeholders
	Seeking synergies in decision-making	Getting in touch with teachers in the community who are known to be creative, to see how they combine their classroom activities with standardized assessments	Finding role models who have open, welcoming, and flexible approaches to their work to get ideas

Note. Skills and subskills columns from Smith et al. (2012).

5.2.3 Creating Optimized Networks

Research has shown that collaboration can help multiliteracies teachers overcome challenges such as a lack of time and the learning curve they are faced with for implementing the pedagogy (Hood, 2015). Similarly, networks are one of the crucial elements of the social entrepreneurial process. Sharir and Lerner (2006) found that a social entrepreneur's social network is the most important variable contributing to their success. Intangible resources such as emotional and practical support, and knowledge are among the top benefits they seek in their networks (Folmer et al., 2018).

Yin and Jahanshahi (2018) conclude that when there is much trust between the members of a social network, the bigger the network is, the more knowledge-based resources the firm has. And when there is a low level of trust between the entrepreneur and the members of their social network, an inverse U-shaped relationship exists between the size of the network and their knowledge-based resources. This means that when there is trust, multiliteracies teachers can benefit from bigger networks as they will have access to more knowledge. However, if they are to establish a network with low levels of trust, they will benefit more from a smaller network because the cost of searching for information in networks increases with their size (Hoang & Antoncic, 2003) and this cost is higher when there is less trust involved (Yin & Jahanshahi, 2018). This also means that even with a high trust level, too much networking may be counterproductive (Watson, 2012).

Entrepreneurial networks are also often analyzed using the concepts of strong and weak ties. According to Martinez and Aldrich (2011) strong ties are "relationships with high emotional commitment and high frequency of contact, usually among socially homogeneous individuals" (p. 8) and weak ties are "relationships with low emotional commitment and low frequency of contact" (p. 8). Although trustworthy networks which usually consist of strong ties provide quicker access to information, they may also have more repetitive information (Watson, 2012) whereas, networks with weaker ties may offer more diversity in this regard (Hoang & Antoncic, 2003).

It would be beneficial to try and take advantage of each network characteristic based on the teachers' stage of work. A new multiliteracies teacher is faced with more work at the beginning of their career which should eventually become less work in the long run through collaboration (Kalantzis & Cope, 2016a). As a result, similar to what social

entrepreneurs do (Bernardino & Freitas Santos, 2019), it is suggested that new multiliteracies teachers start their collaborations within small and trustworthy networks and slowly expand their networks to a manageable and comfortable size as they gain experience. While expanding their networks, they should ensure that diversity of information exists to avoid creating a network of similar ideas being recirculated. For example, a new multiliteracies teacher could stay in touch with a mentor and other teacher candidates who they studied with for emotional support and shared lesson plan creations. Gradually, they can work on projects which are linked to some of the teacher's friends; for example, they have their students create a virtual character for a friend's game developer company, and perhaps the next year, they start collaborating with an employee at the same company on another project.

5.3 Conclusion

Understanding and implementing multiliteracies has not proven to be easy or straightforward for teachers (Boche, 2014; Palsa & Ruokamo, 2015). Therefore, in this study, we set out to contribute to the literature on multiliteracies by looking at it through a different angle which may help develop a new or more comprehensive understanding of the concept. Using this different approach, we were also able to look into the entrepreneurship literature to provide new and practical suggestions for supporting multiliteracies. We believe our work also holds particular value because of its interdisciplinary nature. According to Bloom (2004), as fields of study become more and more specialized, we become "disconnected (a) to the broad connecting conceptions within disciplines, (b) to the patterns that bridge disciplines, (c) to the natural world, and

(d) to each other" (p. 6). This is also in line with the spirit of multiliteracies and the knowledge society (Kalantzis & Cope, 2016c) which consist of distributed systems (Gee, 2000).

As also mentioned in our introduction, our results are limited by the fact that we have considered both ideal versions of multiliteracies teachers, and teacher/social entrepreneurs for comparison. Therefore, the comparison, and hence, support ideas given for multiliteracies teachers are solely conceptual at this point. Another limitation of our work is that for literature on multiliteracies, apart from The New London Group's (1996) original article, we have mostly (not entirely) focused on research carried out by Bill Cope and Mary Kalantzis. Our intention was to keep a certain level of integrity when speaking of the multiliteracies pedagogy, but we understand that this has also led to the elimination of other voices.

For future research, we propose four avenues. First, we would like to see a similar but empirical comparison of the two topics of multiliteracies teachers and teacher/social entrepreneurs to see how conceptual comparisons and real-world comparisons match up and what they translate to in practice. Second, an empirical study which can have pre-service and in-service teachers practice our suggested ideas can provide much perspective on interdisciplinary transferable ideas and how two conceptually similar concepts can or can not feed into each other and why. Third, more possibly compatible ideas exist in the entrepreneurship field which may be worth pursuing. Fourth, we suggest scholars in the entrepreneurship field also study the multiliteracies literature and practice to gain a new and unique insight into entrepreneurship.

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Chapter 6

6 Conclusion

In this chapter I will review the research questions presented in the introduction once again, proceed to synthesize each study, and clarify their interconnections. Overall research contributions and future research suggestions will then be presented which differ from what has already been written for each separate study. Then, I will end this chapter with a brief reflection on the thesis format.

6.1 Review of Research Questions

The main question of this research has been to grasp a better understanding of who teacher entrepreneurs are. To answer this question three subquestions were asked on what literature shows us in this regard, how novice teachers entrepreneurs think and act, and how experienced teacher entrepreneurs think and act. Figure 16 below shows how chapters three through five contributed to the research questions mentioned.

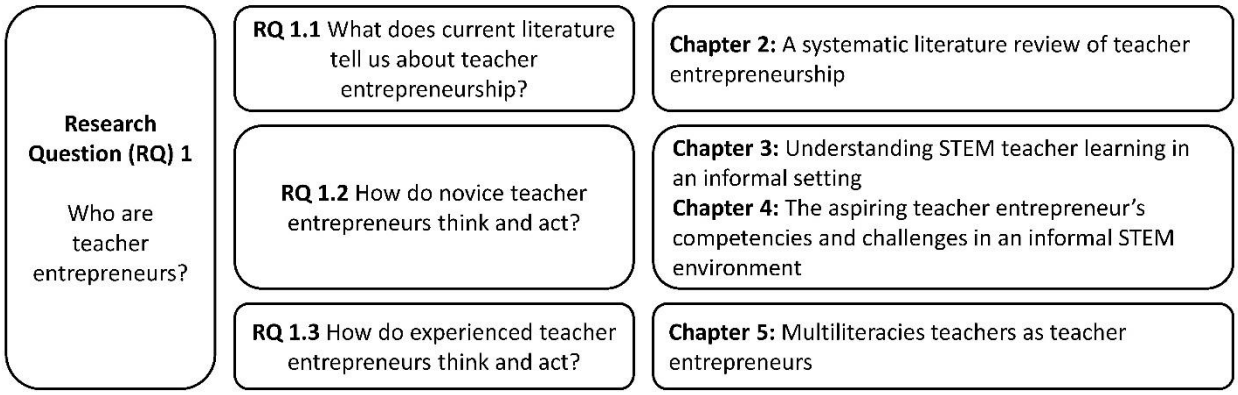

Figure 16. Relationship Between Research Questions and Thesis Chapters.

6.2 Summarizing the Chapters

In this study, the new and growing area of research on teacher entrepreneurship was explored and expanded through four separate but interconnected studies to understand who such entrepreneurs are. Entrepreneurship in itself is widely known to be inconsistently defined (Bridge, 2017) and subject to many misconceptions (Hunter, 2012). In the field of education, entrepreneurship usually takes on a negative connotation which is strongly linked to neoliberal ideas which have commercialized education. According to Giroux (2014) neoliberalism has negatively affected educational values by declaring knowledge a product, considering students as consumers, and appointing teachers as entrepreneurs who let markets shape and guide them. The introduction of scientific management concepts into educational management also labelled educational entities as parallel to business and manufacturing entities which did not prove beneficial from educational perspectives (Au, 2011). Now by no means do I oppose any of the mentioned conflicts and damaging results of business-education partnerships. However, because of my previous knowledge of entrepreneurship and the various meanings it can

take on, I felt the need to shed more light on the type of teacher entrepreneurship which, although carries the weighted name, does not necessarily contribute to the damaging history mentioned above. In this study, the teacher entrepreneur is one who is entrepreneurial in the scope of their educational work and in relation to their classroom and students, who also, as I will mention below, mainly seeks social value, as opposed to financial value.

6.2.1 Chapter Two

The base of this thesis starts with chapter two in which, to recognize what scholarly work on teacher entrepreneurship consists of, a systematic literature review was carried out through database (ProQuest and Scopus) searches and article snowballing. Selection criteria were chosen in a way to ensure the exclusion of pure economic instances of entrepreneurship in which financial value is the main objective. A total of 39 peer reviewed journal articles remained which were analyzed. Most of the articles were written in the past 15 years and emphasized a K-12 setting. Five of the articles, acknowledged the capitalistic notions behind entrepreneurship and made up the performance-oriented view of teacher entrepreneurship where teachers are externally defined and accountable. This view is very closely linked to the negative idea of entrepreneurship mentioned in the previous paragraph where teachers have given in to the standardization of teaching and learning. However, some scholars believe that despite such a definition, advantages also exist to this type of entrepreneurship such as the generation of creative curricula (Hanson, 2017) and higher student achievement results (Keddie, 2018). The remaining of the articles spoke of teachers who can be categorized

as social entrepreneurs, meaning individuals who innovatively combine and use resources to address a social need or achieve social change (Mair & Martı´, 2005). A total of twelve competencies were found in the literature which depicted who such teachers were and how they acted. Findings of the study point to social motivation, innovation, collaboration, proactivity, opportunity mindedness, presence in work, knowledge, dedication, resourcefulness, risk-tolerance, vision, and self-improvement as descriptions relating to a teacher entrepreneur's work. The competencies mentioned are quite similar to competencies mentioned for entrepreneurs in other fields of work, however, their representations differ which are addressed in detail in the chapter. The next chapters delve into the work of novice and experienced teacher entrepreneurs to get a better sense of their behavior, competencies, and challenges.

6.2.2 Chapters Three and Four

Chapters three and four follow the work of a STEM teacher during her first STEM curriculum design and implementation in an informal setting who can be considered both a novice teacher and a novice teacher entrepreneur. For this purpose, her journal entries, artifacts, and lesson plans were studied and analyzed over a period of six weeks where she designs, modifies, and carries out the course she has been assigned to teach. Chapter three takes a look at how the novice teacher's professional identity as a teacher is developed throughout her initial experiences. This analysis was carried out using Baxter Magolda's (2004) self-authorship framework which consists of the stages of following formulas, crossroads, becoming the author of one's life, and internal foundations, and each stage includes an epistemological, intrapersonal, and interpersonal dimension. This

personal identity development framework was initially created to explain the stages college students go through during and after their studies. However, chapter three of this thesis, along with other existing studies (Hunter et al., 2007; Nadelson et al., 2017), show that the framework is also useful in explaining one's *professional* identity development, which in our case refers to a *teacher* identity. The research participant constantly moved back and forth through the first three stages of the framework as they reflected on events, faced new information, and dealt with challenges. The teacher's data showed much emphasis on the epistemological dimension which means knowledge was an important concern which also stood out more easily in terms of progress in the framework. However, the three dimensions are highly interdependent, especially with the interpersonal and epistemological dimensions relying on the interpersonal dimension, meaning approval from stakeholders was crucial in building confidence in the teacher to believe in herself and her knowledge.

Najmeh had knowledge of entrepreneurship, was entrepreneurial in her previous work, and intended to become a teacher entrepreneur. Therefore, we were able to consider her as a novice teacher entrepreneur. As a result, in chapter four, we analyzed her data once again using the teacher entrepreneurship competencies found in chapter two and with the help of the knowledge we gained regarding her identity and behavior in chapter three. Findings showed that some entrepreneurial competencies were visible in her work, however, several of them differed in quality. For example, dedication was clearly seen but the intentions behind it were mostly to gain stakeholder satisfaction and reassurance as opposed to meeting students' needs. Also, her innovations were repetitive, minor, and convenience-based whereas experienced teacher entrepreneurs have been said to exhibit

more diversity in their actions and specifically try to turn problematic situations into opportunities for value creation. The teacher's placement in the self-authorship framework and the interdependencies between the dimensions provided much supporting explanations for our findings. For example, the interpersonal dimension's effects on the epistemological and intrapersonal dimension were seen when the center director's approval of previous ideas showed to have a crucial role in giving the teacher enough confidence in herself and her innovative thoughts to carry out her own ideas. In studying the specific characteristics of the informal STEM setting, we found length of program and stakeholder expectations to cause challenges for Najmeh's entrepreneurial efforts and we presented possible solutions for them based on existing literature.

6.2.3 Chapter Five

After studying the competencies of a teacher entrepreneur from the literature and observing a novice teacher entrepreneur's work, it became necessary to also gain insight from an experienced teacher entrepreneur. Hence, in chapter five we moved on to closely examine the multiliteracies teacher as an example of an experienced teacher entrepreneur. To do so, a detailed conceptual comparison of teacher entrepreneurship and multiliteracies was carried out using the entrepreneurial competencies found in chapter one and canonical multiliteracies literature. Practical examples from a multiliteracies kindergarten classroom were also given throughout the work to help make the descriptions more tangible to the reader. Once the similarities have been explained, from the entrepreneurship field, we adapt and present innovative ideas which can be helpful in supporting multiliteracies teachers. For example, we offer ideas on the different areas

where innovation can be practiced, how paradoxical leadership skills can help multiliteracies teachers cope with the often conflicting forces of students' needs and standardized evaluations, and what kinds of networks can best support multiliteracies teachers based on their stage of work.

6.3 Research Contributions

As each chapter of this integrated article thesis is a standalone piece, contributions for the studies carried out were mentioned in each chapter's relevant section. However, I would like to take the opportunity here to reiterate that teacher entrepreneurship is currently a relatively small but growing field of study. Given the various definitions of entrepreneurship which exist, and the damaging history of schools and curricula being shaped by private interests (Barlow & Robertson, 1994), it is important to have more of a say in how entrepreneurship can or should be introduced into the educational context. This work attempts to demystify the notion that entrepreneurship only serves financial purposes and helps develop the narrative of the teacher entrepreneur as a social entrepreneur, both in theory and practice. Apart from teacher entrepreneurship, as mentioned in the chapters, this thesis also contributes to a number of different educational knowledge areas such as informal education, STEM education, teacher progress and development, and multiliteracies.

I will also point out here that this thesis was written as part of a doctoral program in Education (Curriculum Studies), therefore all the implications and contributions mentioned so far have been to the field of education. However, because of the similarities shown, I believe this thesis also contributes greatly to the field of entrepreneurship,

specifically to social entrepreneurship. And because it helps conceptualize and explore a type of social entrepreneur who is active inside the educational settings they work in, they could also be categorized as a social *intrapreneur* which according to Baets and Oldenboom (2009), refers to "people who make the difference in a company, who innovate and create to deliberately provide value added and a contribution to society" (p. 185). The competencies, actions, and challenges of teacher entrepreneurs presented here can help complement such areas in the broader field of entrepreneurship.

6.4 Future Research

Suggestions for future research specific to each study have been mentioned in the chapters, therefore, I will not be repeating them here. However, when considering the thesis as whole, two other areas of research come to mind which future work can focus on.

First, more studies of entrepreneurship beyond the individual teacher level can give us more insight into the possible synergies of combining entrepreneurship and education. This wider scope of work could mean a wealth of possible studies which I will mention a few here. For example, in this study we focused on individual competencies of a teacher entrepreneur as an individual, whereas entrepreneurship is a process, affected by many other factors such as social, economic, and structural elements (Quintero et al., 2019). Studying the process itself as opposed to the individual entrepreneur could lead to very useful information on different representations of teacher entrepreneurship, better support mechanisms, and various pathways to promote social change. Entrepreneurship is also not a process limited to individuals and can be carried out by schools and educational

institutions as a whole (Eyal & Inbar, 2003). Research on school entrepreneurship itself is also lacking and worthy of attention, especially if aligned with teacher entrepreneurship to see how their impacts can build on one another or become combined. And finally, focusing on the nature of the social value or change which social entrepreneurs aim to reach can also provide much awareness into the process they go through to achieve it (Kimmitt & Muñoz, 2018). This means that teacher entrepreneurs aiming for policy change and those aiming to benefit disadvantaged students in the classroom may go through separate procedures and behave differently.

Second, the initial conceptualization of teacher entrepreneurship presented in this study can be complemented with literature specifically from the entrepreneurship field. It was important for us to start this work using data only from scholarship from the education field, however, now that some similarities have been presented, the work can be improved using existing work from the entrepreneurship field. For example, one important concept which exists in the definition of social entrepreneurship and has been left out of teacher entrepreneurship here is sustainability (Dees, 1998). As explained in chapter five, the social entrepreneur constantly struggles to sustain the social value they create and must at times pursue financial goals which place them in paradoxical situations (Smith et al., 2012). If the social value sought turns out to be a one-time objective, it can be categorized as a single project as opposed to social entrepreneurship. Therefore, the what and how of sustainability for teacher entrepreneurs is worthy of research. Another example can be linked to the concept of *intrapreneurship* which refers to being entrepreneurial inside an existing organization (Desouza, 2011). In-service teachers also fit well into this category as they work within the boundaries of schools or

educational institutions which means beneficial interdisciplinary work can be carried out in this area as well.

6.5 Concluding Thoughts

Overall, this thesis has afforded me the opportunity to work on an interdisciplinary study which enabled me to use both my knowledge from entrepreneurship which I gained while doing my master's degree, and education while studying my Ph.D. at Western University. As with many other research projects, my work evolved many times and an integrated article thesis provided a very helpful format to connect my works together. It also allowed me to expose myself to multiple methodologies and a breadth of knowledge which did not leave me with an overly narrow specialization in the end, making it very well aligned with the nature of an interdisciplinary work. Smaller scope projects provided me with more learning opportunities as I was able to utilize my experience from one to the benefit of the other. This journey also meant more mini milestones to celebrate, making the whole process more mentally manageable.

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Appendices

Appendix A: Letter of Permission to Use Data from Research on Teachers in a Technology-Enhanced Curriculum

June 10, 2020

From 2016 to now, Najmeh Keyhani has been my research assistant. She has been involved in a variety of projects by gathering and analyzing data related to my research on teachers in technology-enhanced environments. My work has an ethics approval from Western University (file #104799) and is accurately titled "A pilot study: Understanding the lived experiences of teachers in a technology-enhanced curriculum".

Najmeh Keyhani has my permission to use data from this research in her Ph.D. thesis on teacher entrepreneurs.

Regards,

Mi Song Kim

Associate Professor, Curriculum Studies

Western University

Appendix B: Initial Ethics Approval Notice

Western Research

Research Ethics

Use of Human Participants - Initial Ethics Approval Notice

Principal Investigator: Dr. Mi Song Kim
File Number:104799
Review Level: Delegated
Protocol Title: A pilot study: Understanding the Lived Experiences of Teachers In a Technology-Enhanced Curriculum
Department & Institution: Education,Western University
Sponsor:
Ethics Approval Date: February 18, 2014 **Expiry Date:** June 30, 2014

Documents Reviewed & Approved & Documents Received for Information:

Document Name	Comments	Version Date
Revised Western University Protocol	Following recommendations, I indicated the revised section in yellow.	
Revised Letter of Information & Consent	Letter of Information for Teachers/School Staff/Volunteer Teachers Consent Form (Teachers/School Staff/Volunteer Teachers) Letter of Information for Parents/Students Consent Form (Parents/Students)	
Instruments	Interview Questions (Pre & Post)	
Instruments	Pre- and Post-Survey	

This is to notify you that The University of Western Ontario Research Ethics Board for Non-Medical Research Involving Human Subjects (NMREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the applicable laws and regulations of Ontario has granted approval to the above named research study on the approval date noted above.

This approval shall remain valid until the expiry date noted above assuming timely and acceptable responses to the NMREB's periodic requests for surveillance and monitoring information.

Members of the NMREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussions related to, nor vote on, such studies when they are presented to the NMREB.

The Chair of the NMREB is Dr. Riley Hinson. The NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000941.

[redacted]

Ethics Officer to Contact for Further Information

✓ Grace Kelly [redacted]	Vikki Tran [redacted]	Mina Mekhail [redacted]	Erika Basile [redacted]

This is an official document. Please retain the original in your files.

Appendix C: Letter of Information from Main Study

Project Title: A pilot study: Understanding the Lived Experiences of Teachers

In a Technology-Enhanced Curriculum

Principal Investigator:

Mi Song Kim, Ph.D. Faculty of Education, University of Western Ontario

Letter of Information for Teachers/School Staff/Volunteer Teachers

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1. **Invitation to Participate**

   You are being invited to participate in this pilot study that will explore the experiences of teachers or facilitators with technology-enhanced teaching and learning because you are engaged in technology-enhanced teaching and learning.

2. **Purpose of the Letter**

   The purpose of this letter is to provide you with information required for you to make an informed decision regarding participation in this research.

3. **Purpose of this Study**

   The purpose of this study is to explore the experiences of teachers/school staff or/and volunteer teachers with technology-enhanced teaching and learning. We will also examine what innovative and effective pedagogical practices are being used in technology-enhanced learning environments and what beliefs, experiences, and practices inform teachers in curriculum preparation and implementation.

4. **Inclusion Criteria**

   Individuals (teachers/other classroom staff or/and volunteer teachers) who implement technology-enhanced learning activities for promoting student learning are eligible to participate in this study. Your students are also eligible to participate in this study.

5. **Exclusion Criteria**

   Individuals who refuse to give informed consent shall be automatically excluded from research.

6. Study Procedures

If you agree to participate, you will be asked to invite the research team to participate in technology-enhanced teaching and learning. The research team will assist you in preparing and delivering technology-enhanced activities in your classroom from September 2014 to December 2014.

- You will be asked to participate in an interview at the beginning and at the end of the study and may also be asked to complete a survey. The interview and survey questions will ask about your perceptions and attitudes about technology-enhanced curriculum, your role, the role of technologies, and your beliefs about teaching and learning. The interview will take about 1 hour and will be audio-recorded and transcribed into written format.
- The research team will observe in the classroom and take notes. If you agree videorecordings will be taken of lessons. Care will be taken to only videorecord those students and staff who have agreed to participate in the study. If others are inadvertently recorded, their likenesses will be altered so that they cannot be identified.
- The research team will also collect your lesson plans and related documents in order to document your ideas and plans for designing a technology-enhanced curriculum.

7. With the consent of parents, students will be asked to complete surveys at the beginning and end of the study and copies of their work will be collected (with permission of the parents and students).

8. Possible Risks and Harms

There are no known or anticipated risks or discomforts associated with participating in this study.

9. Compensation

You will not be compensated for your participation in this research.

10. Voluntary Participation

All participants must provide informed consent before participating in the study. Participation in this study is voluntary. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time with no effect on your future employment status.

11. Confidentiality

The research team will not use your name, the name of the school , the community name, or anything that would reveal the identities of participants in any presentations, or publications of the research.

All data collected will remain confidential and accessible only to the investigators of this study. If the results are published, your name will not be used. If you choose to withdraw from this study, your data will be removed and destroyed from our database.

12. Contacts for Further Information

If you require any further information regarding this research project or your participation in the study you may contact Mi Song Kim [redacted], email: [redacted].

If you have any questions about your rights as a research participant or the conduct of this study, you may contact The Office of Research Ethics [redacted], email: [redacted]

13. Publication

If the results of the study are published, your name will not be used. If you would like to receive a copy of any potential study results, please contact Mi Song Kim [redacted], email:[redacted].

This letter is yours to keep for future reference.

Appendix D: Consent Forms from Main Study

Consent Form (Teachers/School Staff/Volunteer Teachers)

Project Title: A pilot study: Understanding the Lived Experiences of Teachers In a Technology-Enhanced Curriculum

Study Investigator's Name: Mi Song Kim, Ph.D. Faculty of Education

I have read the Letter of Information, have had the nature of the study explained to me and I agree to participate. All questions have been answered to my satisfaction.

Participant's Name (please print): _____

Participant's Signature: _____

Date: _____

Person Obtaining Informed Consent (please print): _____

Signature: _____

Date: _____

Project Title: A pilot study: Understanding the Lived Experiences of Teachers

In a Technology-Enhanced Curriculum

Principal Investigator:

Mi Song Kim, Ph.D. Faculty of Education, University of Western Ontario

Letter of Information for Parents/Students

1. **Invitation to Participate**

   Your son/daughter is being invited to participate in this study that will explore his/her experiences with technology-enhanced teaching and learning because he/she is in a classroom of a teacher engaged in technology-enhanced teaching and learning.

2. **Purpose of the Letter**

   The purpose of this letter is to provide you with information required for you to make an informed decision regarding your son/daughter's participation in this research.

3. **Purpose of this Study**

   The purpose of this study is to explore the experiences of teachers/school staff or/and volunteer teachers with technology-enhanced teaching and learning. We will also examine what innovative and effective pedagogical practices are being used in technology-enhanced learning environments and what beliefs, experiences, and practices inform teachers in curriculum preparation and implementation.

4. **Study Procedures**

   The research team will be in your son/daughter's classroom from September 2014 to December 2014. They will be assisting the teacher in preparing and delivering technology-enhanced activities in the classroom and will be observing the outcomes.

   If you agree that your son/daughter may participate he/she will be asked to complete a survey at the beginning and end of the study and copies of their work will be collected for the research. The survey will take about 30 minutes to complete each time.

   The research team will observe in the classroom and take notes. Videorecordings may be taken of some lessons. Care will be taken to only videorecord those students and staff who have agreed to participate in the study. If others are inadvertently recorded, their likenesses will be altered so that they cannot be identified.

5. Possible Risks and Harms

There are no known or anticipated risks or discomforts associated with participating in this study.

6. Compensation

Your son/daughter will not be compensated for his/her participation in this research.

7. Voluntary Participation

All participants must provide informed consent before participating in the study. Participation in this study is voluntary. You may refuse to allow your son/daughter to participate, your son/daughter may refuse to participate, refuse to answer any questions or withdraw from the study at any time with no effect on his/her grades or academic status.

8. Confidentiality

The research team will not use your son/daughter's name, the name of the school, the community name, or anything that would reveal the identities of participants in any presentations, or publications of the research. All data collected will remain confidential and accessible only to the investigators of this study. If the results are published, your son/daughter's name will not be used. If your son/daughter chooses to withdraw from this study, his/her data will be removed and destroyed from our database.

9. Contacts for Further Information

If you require any further information regarding this research project or your participation in the study you may contact Mi Song Kim [redacted], email: [redacted].

If you have any questions about your rights as a research participant or the conduct of this study, you may contact The Office of Research Ethics [redacted], email: [redacted].

10. Publication

If the results of the study are published, your son/daughter's name will not be used. If you would like to receive a copy of any potential study results, please contact Mi Song Kim [redacted] email: [redacted].

This letter is yours to keep for future reference. Please return the signed consent form to the school if you agree that your son/daughter may participate.

Western Education

Consent Form (Parents/Students)

Project Title: A pilot study: Understanding the Lived Experiences of Teachers In a Technology-Enhanced Curriculum

Study Investigator's Name: Mi Song Kim, Ph.D. Faculty of Education

I have read the Letter of Information, have had the nature of the study explained to me and I agree that my son/daughter may participate. All questions have been answered to my satisfaction.

Student's Name (Please Print):_____

Student's Signature:_____

Date:_____

Parent/Guardian's Name (please print): _____

Parent/Guardian's Signature: _____

Date: _____

Appendix E: Articles Used for Each Teacher Entrepreneurship Competency

Articles used for each competency (page 1 of 2)

Competency*	References
Socially motivated (29)	Amorim Neto, Picanço Rodrigues, and Panzer (2017); Amorim Neto, Rodrigues, Polega, and Persons (2019); Amorim Neto, Rodrigues, Stewart, Xiao, and Snyder (2018); Aurini and Quirke (2011); Berry (2013b); Bills, Cook, and Giles (2015); Borasi and Finnigan (2010); Cochran-Smith, Stringer Keefe, and Carney (2018); Dennis and Parker (2010); Douglass (2018); Eyal and Kark (2004); Hanson (2017); Hess and Finn (2007); Holland, Eckert, and Allen (2014); Hunzicker (2017); Leffler (2009); Maranto (2015); Martin, Abd-El-Khalick, Mustari, and Price (2018); Nash (2014); Omer Attali and Yemini (2017); Oplatka (2014); Pashiardis, Brauckmann, and Kafa (2018); Reeves and Lowenhaupt (2016); Sanchez (2014); Schimmel (2016); Shelton and Archambault (2018); Sherry Chand (2014); van der Heijden, Geldens, Beijaard, and Popeijus (2015); Yemini and Bronshtein (2016)
Innovative (26)	Amorim Neto et al. (2017); Amorim Neto et al. (2019); Bell (2016); Berry (2013b); Bills et al. (2015); Borasi and Finnigan (2010); Bulger, Jones, Katz, Shrewsbury, and Wood (2016); Cochran-Smith et al. (2018); Dennis and Parker (2010); Douglass (2018); Eyal and Kark (2004); Hanson (2017); Hess and Finn (2007); Holland et al. (2014); Leffler (2009); Maranto (2015); Martin et al. (2018); Nash (2014); Omer Attali and Yemini (2017); Oplatka (2014); Sanchez (2014); Schimmel (2016); Sherry Chand (2014); van Dam, Schipper, and Runhaar (2010); van der Heijden et al. (2015); Wilson Kasule, Wesselink, Noroozi, and Mulder (2015)
Collaborative (23)	Amorim Neto et al. (2019); Bell (2016); Berry (2013b); Bills et al. (2015); Borasi and Finnigan (2010); Bulger et al. (2016); Dennis and Parker (2010); Douglass (2018); Hanson (2017); Hess and Finn (2007); Holland et al. (2014); Hunzicker (2017); Leffler (2009); Maranto (2015); Martin et al. (2018); Nash (2014); Oplatka (2014); Pashiardis et al. (2018); Reeves and Lowenhaupt (2016); Schimmel (2016); Shelton and Archambault (2018); van Dam et al. (2010); van der Heijden et al. (2015)
Proactive (16)	Amorim Neto et al. (2019); Berry (2013a); Bulger et al. (2016); Eyal and Kark (2004); Hanson (2017); Hess and Finn (2007); Leffler (2009); Maranto (2015); Martin et al. (2018); Nash (2014); Omer Attali and Yemini (2017); Oplatka (2014); van Dam et al. (2010); van der Heijden et al. (2015); Wilson Kasule et al. (2015)

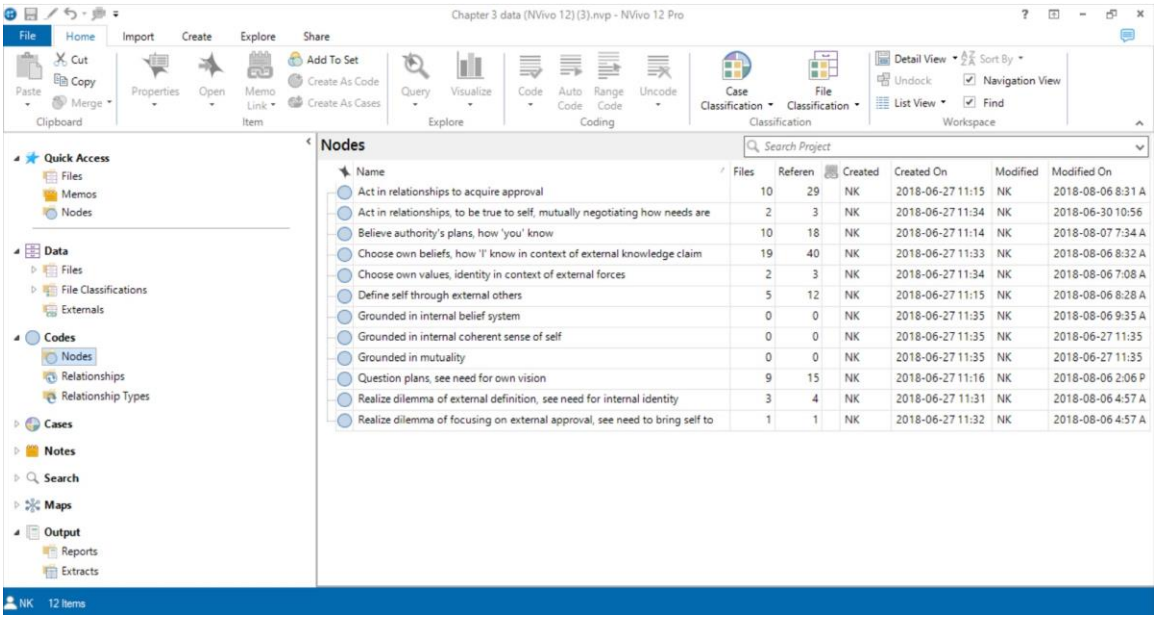
Note. * Number refers to unique references.

Articles used for each competency (page 2 of 2)

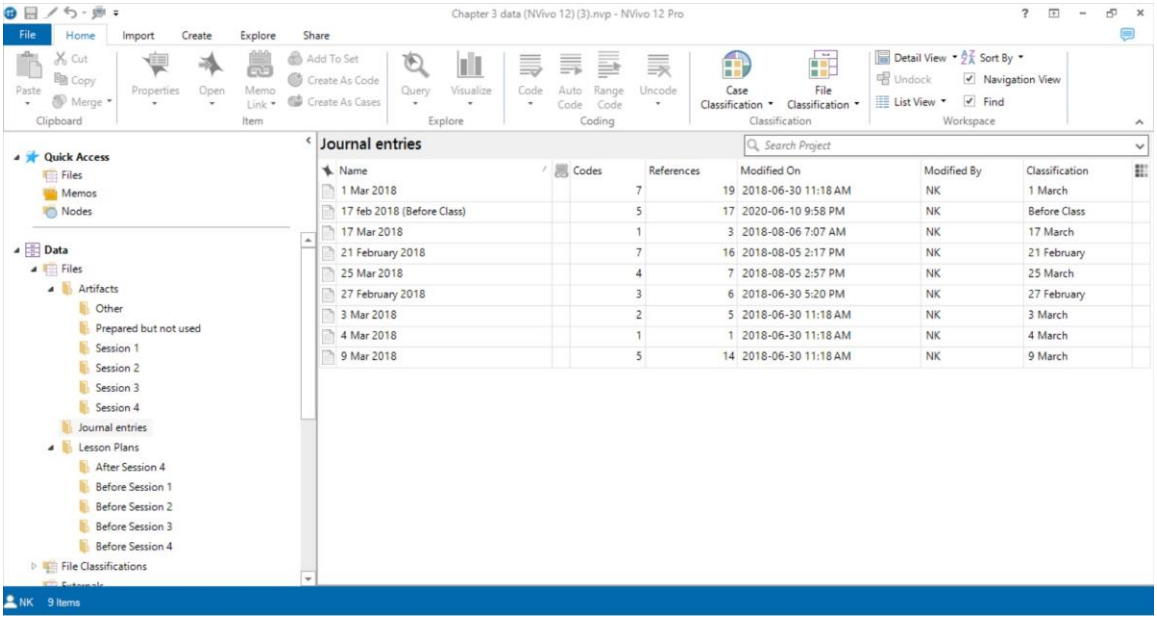
Competency*	References
Opportunity-minded (15)	Amorim Neto et al. (2017); Amorim Neto et al. (2019); Berry (2013a); Borasi and Finnigan (2010); Eyal and Kark (2004); Hanson (2017); Leffler (2009); Maranto (2015); Martin et al. (2018); Nash (2014); Omer Attali and Yemini (2017); Schimmel (2016); van Dam et al. (2010); van der Heijden et al. (2015); Wilson Kasule et al. (2015)
Present in work (13)	Amorim Neto et al. (2019); Berry (2013a); Borasi and Finnigan (2010); Dennis and Parker (2010); Hanson (2017); Keddie (2017); Maranto (2015); Martin et al. (2018); Nash (2014); Oplatka (2014); van Dam et al. (2010); van der Heijden et al. (2015); Yemini and Bronshtein (2016)
Knowledgeable (13)	Amorim Neto et al. (2017); Amorim Neto et al. (2019); Bell (2016); Berry (2013b); Bulger et al. (2016); Dennis and Parker (2010); Hunzicker (2017); Martin et al. (2018); Mikkonen et al. (2018); Nash (2014); Schimmel (2016); van Dam et al. (2010); van der Heijden et al. (2015)
Dedicated (12)	Aurini and Quirke (2011); Berry (2013a); Borasi and Finnigan (2010); Bulger et al. (2016); Cochran-Smith et al. (2018); Hanson (2017); Holland et al. (2014); Keddie (2017); Maranto (2015); Martin et al. (2018); Oplatka (2014); van der Heijden et al. (2015)
Resourceful (11)	Amorim Neto et al. (2017); Amorim Neto et al. (2019); Bills et al. (2015); Borasi and Finnigan (2010); Bulger et al. (2016); Hanson (2017); Maranto (2015); Martin et al. (2018); Nash (2014); Pashiardis et al. (2018); van Dam et al. (2010)
Risk-tolerant (10)	Amorim Neto et al. (2019); Berry (2013a); Borasi and Finnigan (2010); Hanson (2017); Leffler (2009); Maranto (2015); Martin et al. (2018); Schimmel (2016); van Dam et al. (2010); van der Heijden et al. (2015)
Visionary (9)	Bell (2016); Borasi and Finnigan (2010); Hanson (2017); Leffler (2009); Maranto (2015); Martin et al. (2018); Nash (2014); Omer Attali and Yemini (2017); Oplatka (2014)
Self-improvement oriented (8)	Amorim Neto et al. (2019); Bulger et al. (2016); Leffler (2009); Maranto (2015); Martin et al. (2018); Sanchez (2014); Shelton and Archambault (2018); van der Heijden et al. (2015)

Note. * Number refers to unique references.

Appendix F: Screenshot of Code Names and Number of Coded Files and References



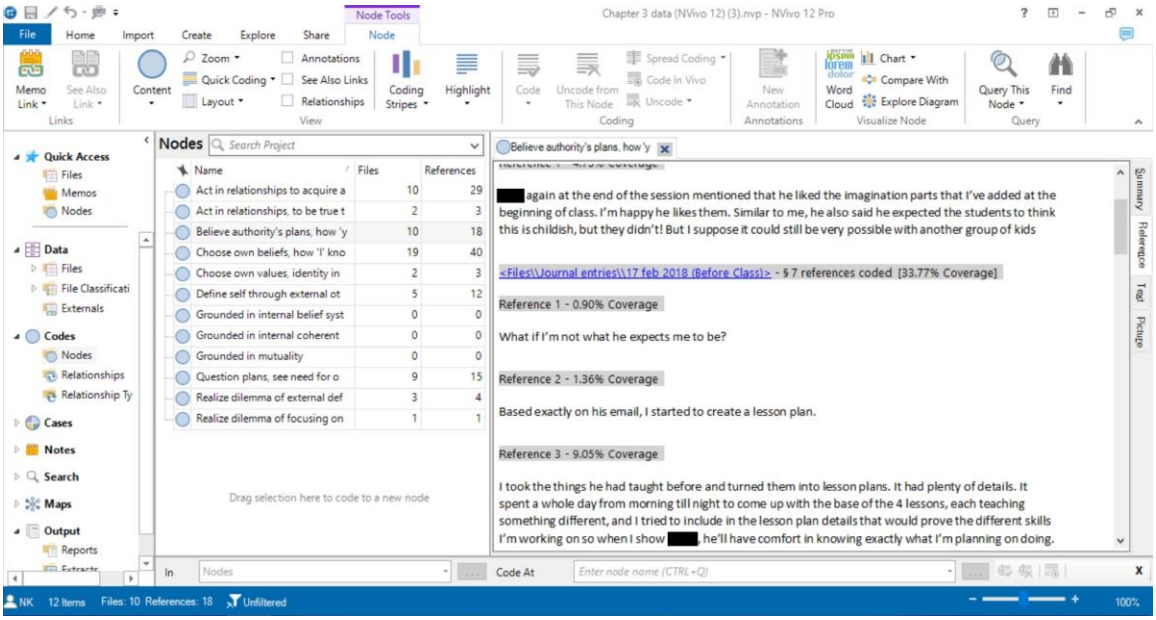
Appendix G: Screenshot of Data Sources Used



Appendix H: Number of References Found for Each Stage of the Framework

	Following Formulas	**Crossroads**	**Becoming the Author of One's life**	**Internal Foundation**
Epistemological dimension: how do I know	18 references from 10 files	15 references from 9 files	40 references from 19 files	0 references from 0 files
Intrapersonal dimension: who am I?	12 references from 5 files	4 references from 3 files	3 references from 2 files	0 references from 0 files
Interpersonal dimension: what relationships do I want with others?	29 references from 10 files	1 reference from 1 file	3 references from 2 files	0 references from 0 files

Appendix I: Screenshot of a Sample of Coded Content



Appendix J: Participant's Final Lesson Plan

Session 1 - Gravit

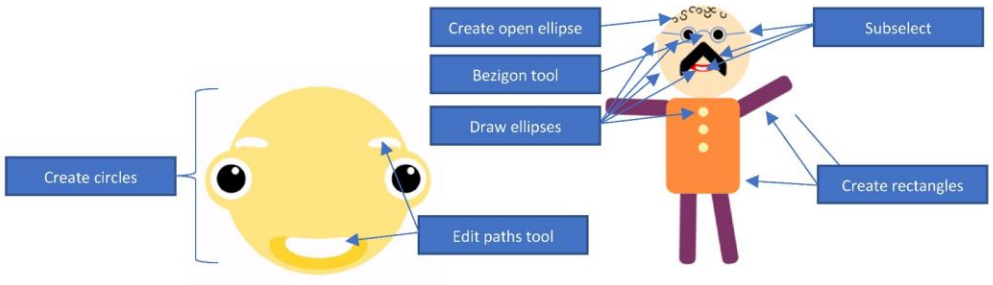
Have teacher account in SCRATCH, create class, studio, students and have kids sign into these accounts when it's time to get into SCRATCH. Save/share all SCRATCH projects in the dedicated studio. So, if students don't have time to code, they can remix the project and simply put their characters inside the ready made game. They have special usernames and passwords for their computer logins so whatever they save, they will be there for next sessions.

Start with slide 2. Ask what their favorite video game characters are. Do you think you'd still like them if they looked really boring and ugly? So, it's important for it to look good, but what does that mean? and it's not just looking good, everything has a meaning behind it. If something is green, it could maybe be related to nature, grass, etc? Red might mean action, shapes could also mean different things based on how they make you feel when you look at them. So professional designing needs a lot of thinking and since what we want to make doesn't exist, we need to master imagination. Imagination is very important for designers, so we'll focus a lot on that.

Give students a sketching notebook. Say write your name on it. What do you do with it? Draw out ideas before creating them, write down ideas for later, if you're on a bus and all of a sudden you have an idea and no computer, you take out your notebook and write/draw.

Next, gather them all in an imagination circle. Close eyes. This is the newest game ever and nobody has played it before! Imagine it's raining, but it's not drops of water, each drop is something different, what drops from your cloud? From mine, a watermelon! what about you? Ask everyone. So who lives in a world like this? The people who live here have no umbrellas! One of the people who lives here wants to make one, what kind of a character would be the first person to make this umbrella? If this was a game you were going to play, what kind of character would you want to choose, that can live there and build an umbrella? We're going to make that person/creature (?).

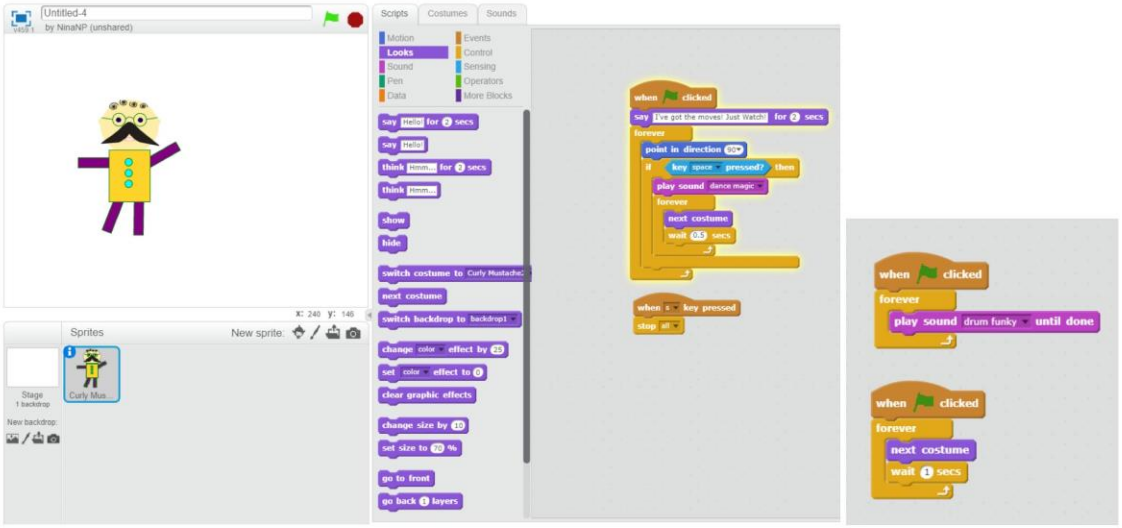
Go to Gravit (https://designer.gravit.io/) and try creating the character [the Director] suggested (https://www.youtube.com/watch?v=tBTJ1tol-fU), or something like the guy on the right. Both characters have plenty of room for modifications. Start with just the head and if there is time left, go to the body. Show on screen and have them do something similar on their computers. Give reasons for things. For example, the guy has a big mustache, so he can keep his tools for the umbrella making in them. Then ask students about their choices. Why is your character like this? Why did you choose that color? What does that sign mean? Save as svg when they are satisfied with it. Then they can make a minor modification and save another svg file which we will use as a second costume. Minor modification could be a change in color, moving a hand/leg, etc.



General tools used: select tool (moving, resizing, rotating), fill and stroke options, flip, bring forward and back, align and distribute, locking layers, etc.

Now, sign in to SCRATCH, import the files as two costumes for one sprite (insert one as a sprite, go to costumes section, and insert the other). An svg file has better quality in SCRATCH than a png or jpeg one, but those can be used as well.

Based on the time left, have them create one of the codes below and make their own modifications as well (slide 3).



To play around with imagination, tell students to choose a backdrop for the character that fits this person where he lives or works, or goes for vacation? When walking around, ask students why they chose that backdrop to hear how they made connections from the character to the backdrop.

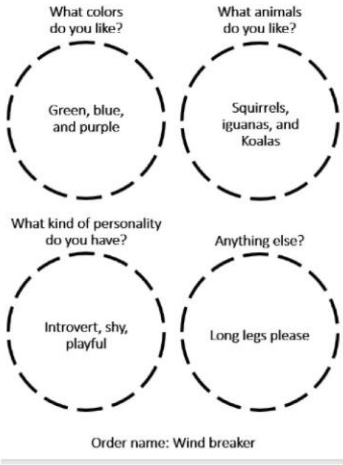
Either have them keep their notebooks in class and make notes about their decisions, or ask them to take it home and bring it back each session with new ideas in it and if they did draw/write anything new, check at the beginning of the class.

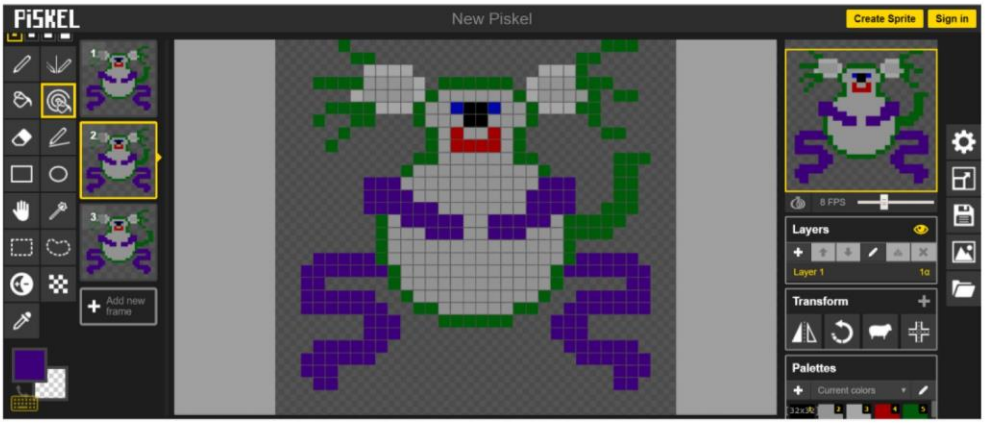
Session 2 – Piskelapp and Magicavoxel

Alright, last session, we made what we wanted, this session, you're going to be professional designers and you're going to have a customer give you an order. But before you get your order, you're going to place an order yourself. Start with slides 5, 6, 7, and 8 to show them how an order can turn into something. Then show slide 9 and tell them this is my order and I'm going to fulfill this on the screen. Then give them a blank order paper for them to fill out. Now mix the orders and give them to new students.

Go to https://www.piskelapp.com and create something based on the order received. For example, this is my order received from my customer (slide 9)...

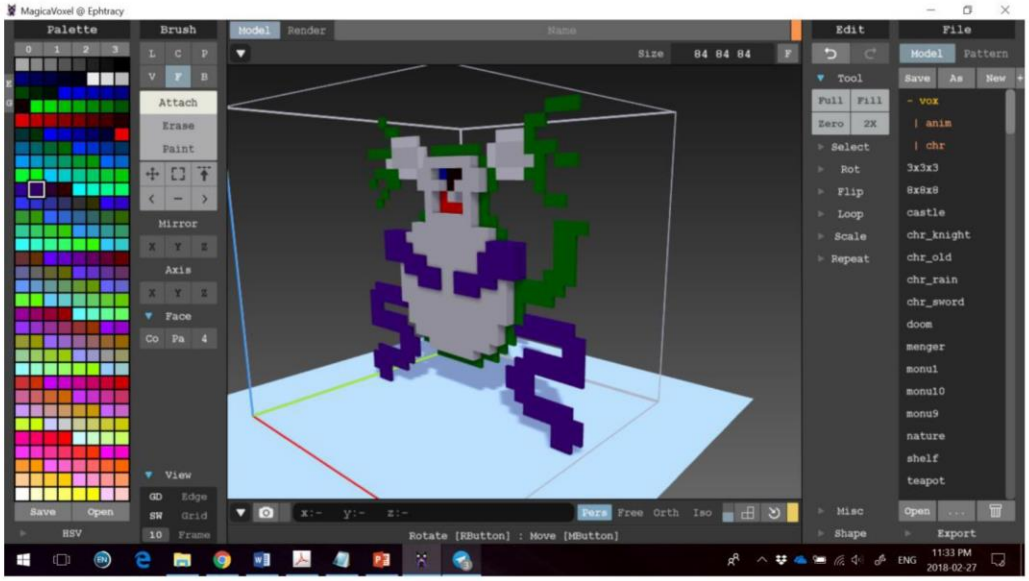
Tell them they can look online for ideas, browse images, etc. Based on my order, I make something like this. Like a koala, with a squirrel tail, the ears I saw from online pics, and they break the wind, the hands are in as it's shy and the smile is big as it's playful.





Copy frame twice and create new costume in third frame. Save as png. If you have more than one frame and save as png they get saved in one picture side by side. So, if you only want one, save before making new frames or delete then save, etc. Save gif and all frames will be saved as different costumes. When exporting gif, if clicked on loop, then it will automatically change costume when opened. When imported into SCRATCH, the other frames will show up as other costumes. Have the tail change or something similar for the other costume if they want. But don't go into scratch yet.

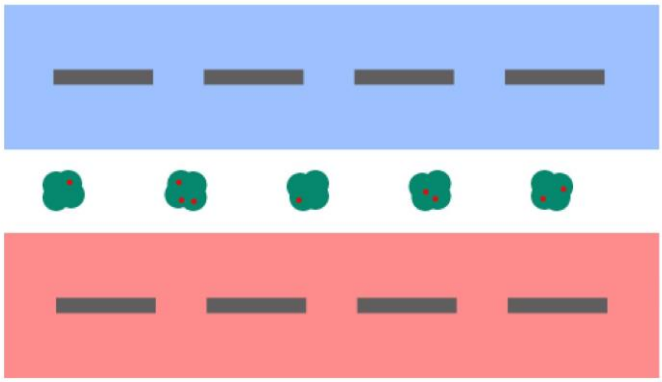
Now go to Magicavoxel and start playing around with it. After a while, import the png saved from Piskelapp and try to make it 3d here.



They can save as 2d which will be png. Now, sign in to scratch and import characters. Have students see their orders by going to that person's computer and seeing what their order turned out to look like. Then have them go back to their own computers.

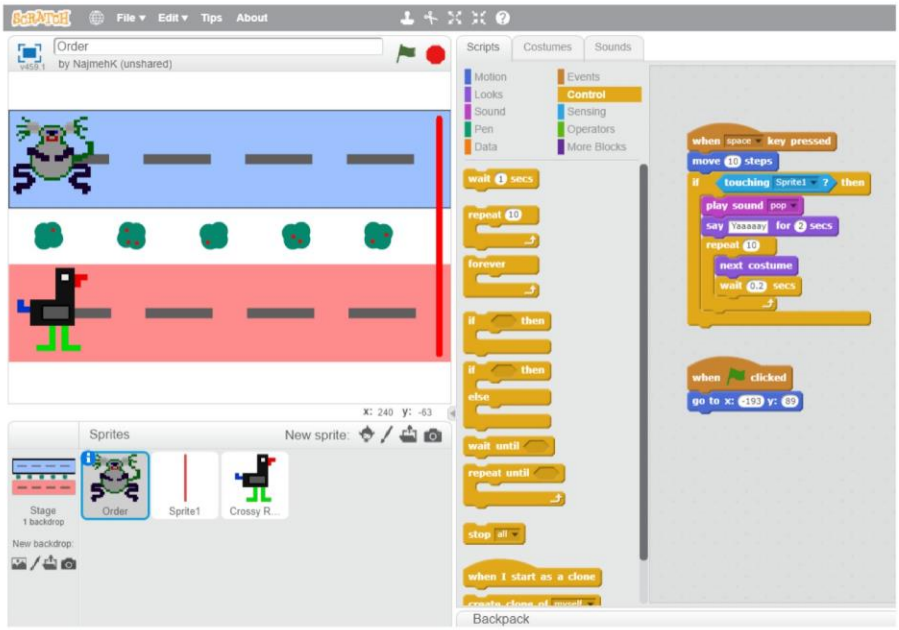
(If students like their order and want to use what someone else made for them, they can import the characters in a file and share so others can access their prepared order if they want).

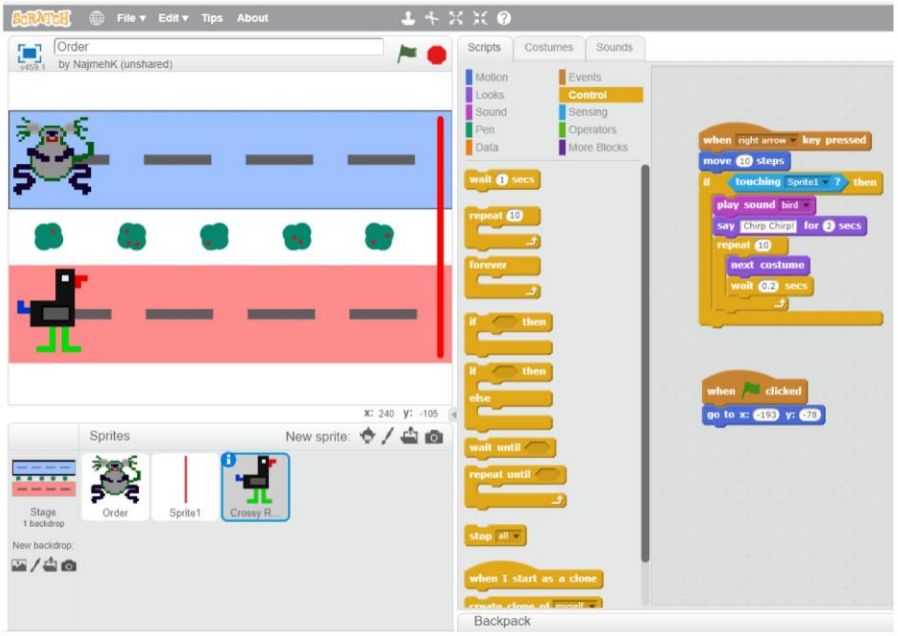
Now IF there is time, go to Gravit and make this backdrop. (I don't think there is time though!)



If there is no time, they can either take the background from here (https://scratch.mit.edu/projects/203944363/) using the backpack feature, add in their own character and another sprite and make the codes below. Or they can remix the project, import their own character, copy codes of one existing character to their own character and delete the character they copied and keep their own instead. Based on the time left, choose what you want them to do. Using the backpack feature may also take some time for them to learn?

(slides 10 and 11)





They can also do the same with the crate game (https://scratch.mit.edu/projects/202583728/). They can go to game and click remix. Insert their character as a sprite, drag and drop the platform codes into their character's script, now play! (If you delete the platform sprite the scores don't work anymore so keep it or figure out what's wrong!).

Session 3 - Mypaint

Each session we've been doing something different, session one we drew with the mouse with Gravit, last session we made our characters by designing the pixels which was really different and cool. This

session we're going to work with graphic tablets which are amazing! A whole new experience so you can see that when you're designing you have so many different ways to design and different options to choose from or even combine them all.

Explain that games have various elements and we spent the last two sessions on making characters. Ask what are some other elements that need graphic designing? For example, buttons, backdrops, words, options tables, etc. Today we're going to work on making a backdrop.

Today we have a problem we're going to fix. There is a game we have that is missing one element. Sign in to scratch and let's check it out. Look at the game "Fish vs. Plastic" (https://scratch.mit.edu/projects/207559787/). It doesn't have a background and it needs a background! So, we're going to make one for it. Let's first play it a few minutes and see how it is. Catch plastics and let the starfish and octopus go.

So now we have to decide what kind of a background it needs. Any ideas? For example, is it under the sea, space, whatever they want. A polluted sea maybe because of all the plastic? What does a polluted sea look like? Maybe it looks like it is a bit unhealthy because there is a mixture of fish and garbage and plastics. Imagine you're a fish maybe? Through the eyes of a fish? Keep these ideas in mind and we'll come back to them. Keep game open in one tab so we can check back on it if we need to.

So, before we start making the background, let's see what software we're going to use today. Again, it's free and you can use it at home too. It's called Mypaint. The difference is that it's like paper. So, you can't really draw something and then move it all around like the last software. Like paper, you draw something and if you don't like it you use an eraser.

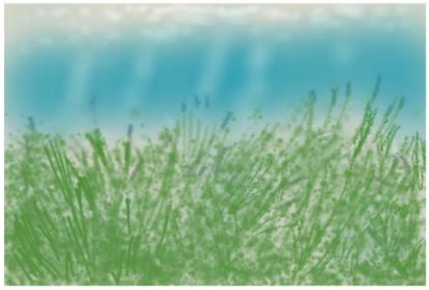
They can test working with my paint a bit, show them how to plug tablets in, open Mypaint, and hold pen on tablet. Open Mypaint, let kids explore a bit and play around. Show them the buttons on the tablet, from the top, brush size+, brush size-, zoom in, zoom out, undo, hand, brush (click again and next set pops up), eraser.

Take a few minutes to play around with the software. Then open a new Mypaint page and click on edit frame option and enter size of SCRATCH backdrop (480*360 pixels) on the right in the settings section. Then choose a picture from Pixabay which we want as our background. Simply drag the picture into Mypaint. If it doesn't work this way, open it in Word, then copy it and paste it into Mypaint. If it's too big, resize it in paint or in Word and try again. Try to choose a rectangle picture if you want it to cover most of the page. Then decrease the opacity and add a new layer and have them trace the picture on the new layer. They can go back to that layer and hide it or delete it whenever they are satisfied. Then they can save it. Sign in to SCRATCH and open the backdrop they made in a remix of Fish vs. Plastic.

If you want to bring in multiple pictures in different layers you can create a new layer and copy and paste the picture from word into that layer. You can also adjust the size of the picture in word before copying and pasting it into mypaint.

If they have extra time, they can create one or two other modifications of the backdrop, a healthier one for when the player has won, and an unhealthier looking backdrop for when the player has lost and everywhere is full of plastic. Or they can play around with the sprites as they wish.

Example:

From this:  I traced this: 

Session 4 – Green screen and magic wand in SCRATCH

Welcome them to the last session. Tell them it's been a wonderful class and how amazing they have all been….

Tell them that there are people who live in countries where it never snows. They want to know how it feels. We're going to show them how it feels for us in 3 different temperatures.

Guide them to the snow game on scratch: https://scratch.mit.edu/projects/210627498/

Point out to them how the game works and the three different backgrounds and weather types. Have students get their 3 pictures taken in front of the green screen or use objects if they prefer that. Transfer their photos to their computers using a cable.

Then have them import/open the photos into their remixed scratch projects as sprites, then go to the costumes section and use the magic wand tool to remove the background. Have them draw over the sections they want to keep. It's better if they don't go very near the edges, and no need to be fussy and accurate. They will have to play around with the tool and then use the eraser for touch ups.

Then they need to replace the existing sprites with their own. They must first copy the codes in the existing sprites to their own sprites by dragging them over to their own sprite. Then they can delete the old sprites.

The first background is matched with sprite number 1,

second background is sprite number 3, and

fourth background is sprite number 4.

They can either put their sprites according to this order or go into the codes and change the numbers which is not very hard. There are three blocks in the bird's script: if answer is … then… They can change those numbers based on their choices, from top to bottom numbers match backgrounds.

If time left, they can bring in new backgrounds as well, but they would have to make sure to change the code names to use those new backgrounds.

* This activity was great, and kids went straight into modifying the game in other ways as well. However, they finished about 15 minutes too soon. They kept playing around with the game but I think there is room to add another small activity.

Curriculum Vitae

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	Ph.D. in Curriculum Studies, Western University London, Ontario, Canada	2016 - 2020
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	Teaching Assistant, Western University Courses: Introduction to STEM Education, Curriculum and pedagogy in STEM, Research and Assessment to Improve Student Learning	2018 - 2020

Publications:

Keyhani, N., & Kim, M. S. (Accepted). Complementing informal STEM education with social entrepreneurship. In P. Patrick (Ed.), *Applying learning theories in research outside the classroom*. Springer.

Keyhani, N., & Kim, M.S. (Under review) The aspiring teacher entrepreneur's competencies and challenges in an informal STEM environment. *Entrepreneurship Education.*

Keyhani, N., & Kim, M.S. (Under review) Multiliteracies teachers as teacher entrepreneurs: A conceptual comparison. *Journal of Education for Teaching.*

Keyhani, N., & Kim, M. S. (2020). A systematic literature review of teacher entrepreneurship. *Entrepreneurship Education and Pedagogy, 0*(0), 1-20. https://doi.org/10.1177/2515127420917355 Kim, M. S. & Keyhani, N. (2019). Understanding STEM teacher learning in an informal setting: a case study of a

novice STEM teacher. *Research and practice in technology enhanced learning, 14*(1), 9. doi:10.1186/s41039-019-0103-6

Kim, M. S., & Keyhani, N. (2019). Understanding STEM teacher learning in an informal setting: A case study of a novice STEM teacher. *Research and practice in technology enhanced learning, 14*(1), 9. https://doi.org/10.1186/s41039-019-0103-6